A theory-driven evaluation of Lesson Study as a model of professional development to support Irish teachers to enact the new primary mathematics curriculum

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CCSS	Common Core State Standards
CPD	Continuing professional development (or in-service)
CSO	Central Statistics Office
DES	Department of Education and Skills (Ireland)
ERC	Education Research Centre (Ireland)
GOI	Government of Ireland
MKT	Mathematical Knowledge for Teaching
NCCA	National Council of Curriculum and Assessment
NRC	National Research Council (America)
OECD	Organisation for Economic Co-operation and Development
OFSTED	Office for Standards in Education
PCSP	Primary Curriculum Support Programme
PD	Professional Development
PISA	Programme for International Student Assessment
RCT	Randomised Control Trial
SET	Special Education Teacher
TDE	Theory-Driven Evaluation
TIMSS	Trends in International Mathematics and Science Studies
ToA	Theory of Action
ToC	Theory of Change
WWC	What Works Clearinghouse

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Dedication

To my 'LOVES' - Leo, Olly, Vivian, Esme and Sadie,

If I had to choose between loving you and breathing,
I would use my last breath to tell you that ***I love you.***

I am so proud to be your Mum.
This is for you, with all my love.

Abstract

It is widely accepted in the literature that Lesson Study is an effective model of PD (Cavey and Berenson, 2005; Hart, 2009; Lewis et al., 2009; Matthews et al., 2009; Perry and Lewis, 2011; Suh and Fulginiti, 2011) and curriculum reform tool (Lewis and Tsuchida, 1997; Stigler and Hiebert, 1999; Fan Yang, 2013; Lewis and Takahashi, 2013; Olander and Sandberg, 2013; Takahashi et al., 2013; Tan-Chia et al., 2013; Ní Shúilleabháin and Seery, 2017).Notwithstanding, Lesson Study is still relatively new in Ireland and there is a paucity of research investigating Lesson Study in Irish schools, particularly at primary level. This research investigated the merit of Lesson Study as a model of professional development to support Irish teachers to enact the new primary mathematics curriculum.

A multi-site case study theory-driven evaluation (TDE) of Lesson Study was conducted in three Irish primary schools (N=9). Over three cycles of Lesson Study, teachers focused on two key research themes related to the new primary mathematics curriculum. To guide and frame the evaluation of Lesson Study, participating teachers were facilitated to generate a programme theory (Donaldson, 2013; Chen, 2015) which made explicit their implicit views and assumptions as to how, why, and in what ways Lesson Study ought to work to support them to enactment this new curriculum. Guskey's (2000) five critical levels of professional development evaluation served as an important conceptual tool for developing the programme theory and evaluating Lesson Study. The test model of Lesson Study implemented in the study was also evaluated, as was the TDE approach itself.

The study found that Lesson Study provided a transformative space where participating teachers could interrogate and try out the new primary mathematics curriculum. The teachers' engagement in Lesson Study resulted in enhancements to their knowledge for teaching mathematics, gains for children's learning, as well supporting them to meet the demands of curriculum reform and change. Moreover, findings from objective measures of the impact of Lesson Study showed positive changes in teachers' questioning as well as statistically significant improvements in children's understanding of Place Value and reasoning skills. In explaining these outcomes, Lesson Study was found to effectively address both internal challenges and inhibitors to curriculum change.

It is aimed that these overall findings will contribute to the knowledge base and academic discourse on Lesson Study, curriculum reform and evaluation of teacher PD in Ireland; and in doing so, minimise the gap between theory, research and practice (Murata et al., 2012). In terms of its original value, this paper is the first academic empirical source to shed light

on Lesson Study as a model of PD to support Irish primary teachers to enact the new primary mathematics curriculum. It is also the first known theory-driven evaluation of Lesson Study conducted in the Irish context.

Chapter 1. Introduction

1.1 Research goals, aims and questions

Generating momentum for change and sustaining this change is a key challenge facing education policy and decision-makers today (Pont, 2018). This is particularly the case in Ireland as primary school teachers anticipate the publication of a new primary mathematics curriculum, one of the first in a new suite of curricula to be introduced to Irish primary schools in the coming years. Beyond curriculum development, a key reform challenge in achieving a new vision for children's learning is embedding new pedagogy and practices in classrooms (NCCA, 2016b). Professional Development (PD) plays a critical role in supporting the enactment of new curriculum and in doing so translating policy aspirations into lived curriculum experiences.

Lesson Study is a Japanese model of teacher-led research and PD where teachers work collaboratively to target an identified area of development for their children's learning (Lewis, 2002; Takahashi and Yoshida, 2004); and is commonly used in Japan to support the enactment of curriculum reform and revisions (Takahashi and McDougal, 2016). As will be further explored in Chapter 2, research shows that Lesson Study has been successful in supporting teachers across various contexts such as pre-service education, in-service education and curriculum reform; as well as being found to be an effective model of PD and curriculum reform tool in several jurisdictions, including Ireland. Notwithstanding these successes, the merit of Lesson Study to support the enactment of new curriculum at primary level in Ireland has, until now, not been empirically investigated. Accordingly, the overall goal of this research study was to investigate the effectiveness and merit of Lesson Study as a PD model to support the enactment of the new Irish primary mathematics curriculum.

The research context and timing of the study is particularly important as it is situated in the space between the development and publication of the new primary mathematics curriculum and thus aims to offer insights which will inform policy and decision-making regarding the model of PD that will attend the new primary mathematics curriculum. In doing so, this research has been timed so as to contribute to the planning for enactment of the new curriculum during the development phase, as strongly recommended by Walsh (2016). The study is a multi-site case study evaluating Lesson Study in three Irish primary schools, where nine teachers were facilitated to engage in three cycles of Lesson Study,

over a four-month period. Through Lesson Study, these teachers planned, enacted and reflected on their practice with the new primary mathematics curriculum.

To fulfil the research goals, this study aimed to provide credible evidence to determine if Lesson Study worked (i.e. provided an effective means) to support the enactment of the curriculum. In this endeavour, the study evaluated the impact of Lesson Study across a number of levels, not least in terms of teachers' professional learning and practice; and children's learning outcomes. Importantly, in response to recommendations put forward by Lewis et al. (2006), this study also investigated why Lesson Study worked, how it worked, for whom it worked, and in what conditions.

The research design adopted to investigate and evaluate Lesson Study was a theory-driven approach to evaluation (TDE). A TDE approach enabled the researcher to generate a programme theory which provided a conceptual framework for designing, conducting, interpreting and applying the Lesson Study model adopted in the study (Coryn et al., 2011). This programme theory explicated the implicit views and assumptions of the main consumers of this new curriculum, namely primary teachers. In particular, it made explicit teachers' assumptions about the underlying mechanisms of change, i.e. the contextual and causal factors that believed would need to be in place in order for Lesson Study to be successful in supporting them to enact the new mathematics curriculum. This programme theory was tested and, in doing so, the causal relationships between the intervention (Lesson Study), its determinants, intended outcomes, and the conditions under which it was implemented were made exposed and analysed. Evidence of the impact of Lesson Study was generated through the lens of Guskey's (2000) five critical levels of PD evaluation, and the analysis of these aforementioned causal relationships provided a basis for determining the viability and effectiveness of Lesson Study as an attendant model of PD to support the enactment of the new primary mathematics curriculum.

In terms of generalisability and transferability of the research findings, data and evidence gathered over the research period served to define the conditions and determinants necessary for Lesson Study to be successful in supporting Irish primary curriculum enactment. Moreover, the programme theory was refined with participants, providing a useful output of the study in the form of an evidence-based and tested implementation model of Lesson Study for supporting Irish primary teachers to enact the new primary mathematics curriculum. Finally, given that a review of the literature show little evidence of the use of theory-driven evaluation (TDE) in the context of educational PD evaluation

research, the evaluation findings also offered insights into the usefulness and value of TDE as a research evaluation tool in this case.

In this research study, the implementation of the Lesson Study intervention, the research design, and data collection and analysis approach were underpinned by consistent values of professional autonomy and agency, professional efficacy, transparency, and collaboration, among others. It is hoped that, in addition to the methodological approach employed, this consistency gives credence to the findings and recommendations that emerge from the evaluation.

1.2 Philosophical approach

The current educational context of curriculum reform in Ireland had a strong influence on the philosophical approach adopted in this study. While the researcher does not reject the notion of objective truth or the idea that there are known truths and positivist methods of social research, this study was situated in a particularly finite space, which posed a challenge in how to address the research question in a timely manner. Accordingly, a pragmatist approach to the research was adopted.

This pragmatist approach is predicated on a core realist ontological position that the social world we live in is so infinitely complex that we, as finite human beings, cannot generate a sufficient solution to address the complex nature of our reality. As such, no one single point of view can provide the full picture and there may be multiple perspectives of reality. Thus, attempts to generate claims to absolute truth/s about social reality, particularly in the context of this study, are unachievable, futile and unrealistic in practice. Aligned with this stance is the epistemological position that uncovering practical consequences or real effects of actions, is the best we can hope to achieve in determining truth or meaning. This stance is in keeping with pragmatists such as William James (1907; 1909), John Dewey (1999) and Charles Stuart Pierce (1999) who hold that for every truth claim you ought to demarcate a situation in which that claim is valid. Furthermore, the validity of this claim can only be determined by the degree to which the predicted outcome for an action is in keeping with the actual outcome. In other words, if what one thought or predicted would happen, actually happened to a reasonable degree, then that claim is true enough.

The ontological and epistemological stances adopted in this study "side-steps the contentious issues of truth and reality" (Feilzer, 2010, 8) and acknowledges that there are

many ways of interpreting the social world and undertaking social research. Suitably, a pragmatic approach to the research was chosen as it focuses on the research problem (Creswell and Plano Clark, 2011) and tries to find solutions or determine 'what works' as the truth regarding the research questions under investigation (Tashakkori and Teddlie, 2003, 713). As such, understanding and explaining the causal link between theoretical ideas (and interventions) and actual effects or events was critical to gathering and inferring knowledge to explain truth and reality. Blatter and Haverland (2012, 12) hold that in order to infer causality, it is necessary to dig deeper into the social world by casting a spotlight on "the processes, temporal sequences, underlying mechanisms and conditionalizing contexts that constitute social entities and have causal effects in the social world". Accoordingly, this approach helped to explicate the assumptions that underpin knowledge and inquiry. and in doing so, was useful in answering 'what', 'why', and 'how' research questions (Saunders et al., 2009) that were central to the research goals of this study.

This philosophical approach also had strong influence on the evaluation methodology selected to address the research question. In acknowledging that an evaluation in this PhD study could not achieve absolute or definitive proof, it was intended then that the selected evaluation methodology might best strive to contribute to a better understanding of whether, how and why an intervention, such as Lesson Study in this case, has merit. The philosophical approach also provided a basis for practical research by integrating different perspectives which helped to enrich the data interpretation process (Saunders et al., 2009) and provided the justification and rationale for combining approaches and methods in the study (Johnson et al., 2007).

Theory-Driven Evaluation (TDE) was chosen as the most suitable methodology to achieve the research goals. TDE has its philosophical roots in critical realism (Koenig, 2009), a paradigm in which knowledge is believed to be socially and historically constructed. TDE is based on the premise that causal mechanisms reside in social relations and context as much as in individuals. It assumes that nothing works everywhere for everyone and that context plays a significant role in programme outcomes (Pawson and Tilley, 1997). Interventions can be understood to work, or not, because actors take up what is offered by the intervention, or not. The actors and the intervention are embedded in a "stratified social reality" (Ibid, 64). Realist inquiry has an explanatory focus and aims to unravel mechanisms of change by explaining the links between causality, mechanisms and context. Realism bases this explanation on the perspective of generative causality, taking into consideration the interaction between the actors and the intervention, as well as specific

context elements and mechanisms, which cause certain outcomes to occur (Ibid). Importantly in the context of this study, a theory-driven evaluation posed the opportunity to ask not only if Lesson Study works but also, importantly, how or why it works, for whom, and in what circumstances?

1.3 Researcher positionality

Within a pragmatist stance, values have an influence throughout the research process, from the choice of area to study, the research questions, methodology, mode of data analysis and ultimately the conclusions that are drawn from the study (Bryman, 2008). As "all writing is positioned and within a stance" (Creswell, 2007, 179), I intend to make my potential biases, assumptions and values clear to the reader (Creswell, 2009).

I am a primary school teacher currently seconded to the National Council for Curriculum and Assessment (NCCA). The NCCA is a statutory body with responsibility for research and development of the curriculum and assessment for early years, primary and post-primary education in Ireland. As part of my role as Education Officer with the NCCA, I hold responsibility for leading the development of the new primary mathematics curriculum. Previous to my appointment as a curriculum developer, I worked with a large number of teachers to support their PD in mathematics, as well as a wide range of other areas, across all levels of teacher education, including pre-service, induction, and continual PD level. My professional experience and history has afforded me a broad range of experiences from which I have developed a keen interest in educational change and teacher professional learning and development; and from which I can attest to the influence that PD, when done well, has to improve teaching and learning and transform pedagogical practices.

Primary teachers' views of PD, shared in focus groups conducted by the NCCA in Autumn 2015 (NCCA, 2016b) in relation to the new primary mathematics curriculum offer perspectives that are largely reflective of my own observations and experiences when working with teachers to support their PD. In this focus group study, teachers called for school-based PD to support the enactment of new curriculum. Teachers expressed that PD should help teachers to understand mathematical progression and show teachers "what maths really is" (Ibid, 15). Teachers also reported that a lack of self-confidence in their own mathematical ability and attitudes to mathematics has a strong impact upon how they approach teaching mathematics and that PD is critical to support teachers to enact the new curriculum. Focus group finding analysis indicated that "the type, quality and effectiveness

of professional development offered will undoubtedly impact the implementation of the new primary mathematics curriculum, and so, the provision of professional development should be factored into the new mathematics curriculum discussions and consultations" (Ibid, 15).

Professional learning and development is central to a new agenda for teachers as professionals in Ireland, as evidenced by recent policy, namely Cosán, the National Framework for Teachers Learning in Ireland (Teaching Council, 2016). This new policy for teacher education is underpinned by core democratic values of professional autonomy, flexibility, relevance and quality, accessibility, acknowledgement and impact. It facilitates teachers to value their learning and prioritise learning that benefits them and their students. Furthermore, it offers teachers autonomy to plan their professional learning to take account of the changing needs of their students, and their own personal and professional needs. This policy contrasts with traditional managerial agendas of professionalism, which have tended to value top-down approaches to professionalism over teacher-led and teacher-driven approaches (Kennedy, 2014).

My personal learning journey has enabled me to witness the influence that both policy approaches have on teacher's experiences of teaching and professional learning as well as the implications of this in practice. This journey has influenced my beliefs and values which recognise the importance of teacher democracy and professional integrity; teachers taking charge of their own decision-making; and teachers making their own value judgements based on professional freedom, social justice and knowledge of research and best practice. These beliefs and values are reflected not only with the choice of intervention selected to evaluate but also the philosophical approach taken, the choice of methodology selected for this study and the process of obtaining and analysing data.

1.4 Process of obtaining and analysing data

Given the rationale for the philosophical approach taken in this study, the methodology adopted for this research is a means of obtaining and analysing data, as well as an end in itself. The process of obtaining and analysing data aligns with the transformative nature of Lesson Study, by engaging participants in a cyclical process of reflection, change and action.

Through a series of facilitated steps, teachers participating in this research were presented with and encouraged to consider the embedded research questions and issues to be

addressed in the study. They contributed to the development of an initial programme theory, hypothesis, and model/framework which was later tested in the study. They also discussed and shaped what data was used to test each aspect of the programme theory, as well as consulted on the analytic techniques used with particular data sets. The programme theory generated by the participant group was used to evaluate Lesson Study and documented their experiences, generate evidence and make sense out of the situation (Reason, 1988). Following the Lesson Study intervention, the participants also discussed disaggregated outcomes and contextual considerations for different sub-sets of data identified in the programme theory. In concluding the evaluation, evidence from the evaluation was synthesised and presented to the participants to provide a transparent basis upon which to make their summative judgements about Lesson Study (against the programme theory).

In taking a holistic approach to the evaluation methodology, two types of theory which together comprise the programme theory, were investigated; namely *change theory* or Theory of Change (ToC); and *normative theory* or Theory of Action (ToA) (Chen, 2015). The ToC aligned with Guskey's (2000) five critical levels of PD to define the anticipated outcomes of Lesson Study and then map backwards to identify necessary pre-conditions. Participating teachers were facilitated to articulate the process of change or impact from their own perspectives, by outlining a path of anticipated causal linkages. In doing so, the teachers made explicit a list of outcomes and determinant for Lesson Study success across the following five levels (Guskey, 2000):

- Level 1 Teachers' reactions
- Level 2 Teachers learning of new knowledge and skills
- Level 3 Organisational support and change
- Level 4 Teachers use of new knowledge and skills
- Level 5 Children's learning

Notwithstanding the importance of this data, Chen (2015) holds that the merit or impact of an intervention is only one part of programme evaluation. Evaluations should also determine "needed improvements … [or] provide information that helps stakeholders do better" (Ibid, 23). The evaluation thus also generated "contextual and transformational information" (Chen, 2015, 21) which also subsequently assisted participants to refine the programme theory for future purposes.

Given my professional role, I was careful to ensure that data was not selectively highlighted to suit my own agenda. Likewise, given my philosophical stance, I am mindful that analysis

of study findings is open to many interpretation. As such, and in compliance with the University of Lincoln's Research Ethics Policy (2018), all data analysis documentation will be maintained for a period of three years in case any bias is questioned or investigated by other parties.

1.5 Terminology

Given that there are a number of terms in this document that may be unknown to the reader, this section sets out to make clear the intended meaning and significance of specific terms used in the thesis.

The term 'implementation' is predominantly used in the literature to describe how curriculum reform efforts are put into practice. However, it could be argued that this is symptomatic of a managerial concept of professionalism and a transmissive concept of teacher PD (Sugrue, 2011). In moving towards a new paradigm of transformative professional learning and development of teachers, it is appropriate that the language that is used to describe how curriculum reforms are put into practice is in keeping with this new way of thinking. As such, in this thesis, unless referencing another source, the term 'enactment' is explicitly used to describe the integration and assimilation of new curriculum into teachers' classroom practice.

Teacher professional development is a complex term within the literature, with many terms categorised within this umbrella e.g. staff development, lifelong learning, continuous PD, or in-service (Crawford, 2009). Often authors conflate these elements while others attribute different meaning and significance to them depending on their frame of reference (Campbell, 2015; Campbell et al., 2016). In evaluating Lesson Study as a model of PD, I specifically intend to examine Lesson Study in the context of PD to attend the introduction of new curriculum, sometimes referred to in the literature as curriculum in-service (Murchan et al. 2005). Given the prominent use of the term PD in Ireland, this term will be used predominantly in this thesis. The terms 'CPD' or 'in-service' will be used in direct reference to the literature only, and with consideration of the authors' intended meaning and significance.

Similarly, a review of the literature shows that the terms children, students and pupils are also used interchangeably. In this thesis, the term children will be used as this is the term predominantly used in curriculum publications. The terms 'students' and 'pupils' will be

used in direct reference to the literature only. Furthermore, throughout the thesis, reference to children's learning outcomes will be made. However, for the purpose of clarity, when Learning Outcomes are treated as a proper noun (i.e. capitalised), this is to signify to the reader that they refer to explicit Learning Outcomes cited in the new primary mathematics curriculum.

Another important distinction to make for the reader is that when discussing teachers in general, the term 'teacher' will be used. When discussing the research participants in the thesis, the terms teachers and participants may be used interchangeably. If a meaningful distinction needs to be made, then the term 'participating teacher/s' will be used. When referring to the teachers participating in the research study, I will explicitly use the term 'participating'. When I am referring to the teacher's participation or engagement with Lesson Study, I will use the term 'engaging'. A further point of clarity is that in this study, research was conducted with children in senior infants. This refers to a specific class or grade level in Ireland. Senior infants is the second year of primary school in Ireland and children typically enter senior infants at 5 or 6 years old.

Finally, in this research study, reference is made to the new primary mathematics curriculum. The curriculum specification used in the study was a draft of the new curriculum that was published in Autumn 2016 for the purpose of consultation. Given that historical analysis of curriculum implementation in Ireland over the past 100 years highlights a paucity of planning for curriculum implementation, particularly during the development phase, and a lack of focus on methodical and continuous evaluation of implementation (Walsh, 2016), it was an imperative of the study to gather empirical data in preparation of the publication of the final curriculum specification, estimated for Autumn 2021. The curriculum draft used in the research study can be found on the NCCA website at https://www.ncca.ie/media/3148/primary_mathsspec_en.pdf. The two specific aspects of the draft curriculum that were isolated and investigated in the evaluation - Place Value Learning Outcomes at Stage 1 and adaptive reasoning were not subject to change as a result of the consultation and as such will be evident in the final curriculum published.

1.6 Overview of chapters

This research aims to build on the extensive body of extant research and literature focusing on PD as a tool for education reform, in a bid to inform policy and practice during a period of primary curriculum reform in Ireland. The study investigates the space between

curriculum development and curriculum enactment, and explores the merits of Lesson Study as a model of PD to translate and catalyse curriculum policy intentions into lived curriculum experiences.

Chapter 2 will begin with an exploration of the extant literature on the challenges of bridging the gap between intended and enacted curriculum. In particular, research on the impact that teachers and the school context have on curriculum reform efforts will be examined. Historical analysis of curriculum reforms in Ireland and the role of PD in supporting curriculum enactment will also be explored as the foundation for supporting and informing future curriculum reform efforts. Lessons learned from previous research will be contextualised in terms of the new primary mathematics curriculum and a summary of the ensuing changes and implications for this research study will outlined. Extant research and literature on Lesson Study as a model of PD will then be discussed, particularly in terms of supporting curriculum enactment in mathematics and in the context of the key changes and implications identified. Finally, literature exploring the evaluation of PD in support of evidence-based policy and decision-making will be presented in this chapter before introducing the aims, objectives and research questions of this study to address identified gaps in the literature.

In chapter 3, the reader will be provided with an overview of the study and a profile of the participant sample. This chapter will then introduce theory-driven evaluation as an evaluation framework and methodology for evaluating PD. The research design will describe how the multi-site case study and Guskey's (2000) framework for evaluation was employed in the theory-driven evaluation of Lesson Study. Moreover, the reader will be guided in the explication and design of the programme theory as well as provided with a comprehensive overview of the data collection and analysis tools and techniques employed over the course of the study. Finally, methodological rigour and robustness will be discussed, and the steps adopted to ensure same will be outlined.

Chapter 4 reports the findings from testing the initial programme theory and the objective measures taken on the impact of Lesson Study on teachers' practice, namely questioning and children's learning outcomes with the new primary mathematics curriculum. Summative feedback on participants experience with Lesson Study and the TDE process are also included in the findings. Finally, Chapter 5 synthesises these findings in the context of the key research questions and in relation to the literature before drawing all of this together in the final conclusion chapter, where new knowledge and the merit of Lesson

Study as a model of PD to support Irish teachers to enact the new primary mathematics curriculum is discussed, along with implications for policy and practice, as well as recommendations for future research.

Chapter 2. Literature Review

2.1 Research context

Primary curriculum in Ireland is currently in a period of systematic rethinking and consultation (NCCA, 2016a). Research and national policy developments have pointed towards new directions and emphases for primary education and for the experiences of children in our primary schools. This research took place in advance of a suite of proposed reforms, more specifically the introduction of a new primary mathematics curriculum. In addition to enhancing education standards and school improvement, the main impetus for developing a new primary mathematics curriculum arises from contemporary thinking and research that offer fresh insights into "how children learn and why they learn in particular circumstances" (NCCA, 2016b, 2). This new understanding has concomitant implications on the teaching of mathematics in classrooms, requiring a fresh pedagogical focus and reorientation of practice to facilitate children to develop their mathematical proficiency (NCCA, 2016b). Notwithstanding this policy aspiration, Takahashi and McDougal (2016) caution that changing *how* mathematics is taught is far more challenging than changing *what* mathematics is taught. As such, it holds that the full challenge of actualising the new primary mathematics curriculum in the classroom cannot be met by the development of a curriculum specification alone, but rather, as Takahashi and McDougal (2016, 516) propose, through PD opportunities for teachers that focus on their knowledge for teaching and their expertise for teaching. In terms of the new primary mathematics curriculum, it is proposed that attending PD should develop teachers' ability to apply new knowledge and skills to their practice and orient their teaching to provide for rich learning experiences in the classroom (NCCA, 2016b). These experiences include opportunities to collaborate, talk and think aloud with others, to develop their innate and intuitive ability to think and communicate mathematically, to reason and problem-solve and to make sense of their world using mathematics (Ibid).

In general terms, it is becoming increasingly apparent that national policy development is the least complex step in the educational change and reform process (Sarason, 1990; Fullan, 1993; Evans, 1996). A number of authors have written about the failure of curriculum reforms to bring about pedagogical transformation in classrooms; for example, in the U.S. Berman and McLaughlin (1976) and Ball and Cohen (1996) and, in Singapore Hogan et al. (2013). Others have highlighted the challenges of introducing new reform

approaches in the complex environment of teaching (O'Shea and Leavy, 2013). In Ireland, previous reviews and evaluations of primary curriculum implementation (DES, 2005; NCCA, 2005) show how incongruities can exist between the intended curriculum and how it is implemented, with Looney (2014, 8) adding that "curriculum aims are rarely a good guide to curriculum experiences". Given both the shortcomings of previous curriculum policy efforts to effect change (Sugrue, 2011; Murchan et al., 2005; Murchan et al., 2009; Harford, 2010) and the new proposed changes to primary mathematics curriculum, this research is timely. It is an aim of this research that in addition to contributing to the knowledge base, this empirical study will contribute to the literature and research base that policymakers may consult when formulating the model of PD which will be provided to teachers to support the enactment of the new primary mathematics curriculum following its proposed publication in 2021.

2.1.1 The challenge of curriculum reform

Education is a complex system, and its reform is even more complex (Fullan and Miles 1992). The formal reform and development of curricula across all levels of the education system has been ongoing in Ireland and internationally in recent years. The drivers for curriculum change have been explored extensively in the literature [see Fullan, 2005; Hargreaves and Fink, 2006; Sahlberg, 2009]. Suffice it to say, the fundamental necessity and basis for reform, stems from the aspiration "to pursue the highest standards of quality for the benefit of students, society and the economy" (DES, 1995, 110). Despite recently mandated curriculum changes to mobilise education policy reforms in Ireland (Walsh, 2016), it would be naive to assume that intended and enacted curriculum necessarily fully correspond. It is widely held that the reform of mandated curriculum alone does not guarantee curricula or pedagogy are transformed (Berman and McLaughlin 1976; Ball and Cohen, 1996; Harford, 2010; Hogan et al., 2013). Rather, it could be said that curriculum change in itself, is a weak predicator of change in terms of pedagogy and classroom learning experiences (van den Akker, 2004; Looney, 2014).

A recently published historical analysis of primary school curriculum development and implementation conducted by Walsh (2016) traced three cycles of curriculum reform in Ireland over the past century. Walsh posited that when curricula were revised and disseminated, "the work of the central authority and the event of curriculum change was seen to be largely complete" (2016, 12). However, a critical shortfall of each reform effort identified was the lack of strategic focus beyond the curriculum development stage,

particularly on enactment or the "roadmap required for teachers to fully actualise reform in classrooms" (Ibid). Thus, it could be suggested that previous reform efforts reflect what Sahlberg (2009, 1) describes as "an over-simplistic approach in trying to change the existing practices and modes of thinking in schools".

The quality of education provision is crucially influenced by "the way in which the curriculum is defined, planned, implemented and evaluated" (DES, 1995, 19). However, correspondingly, many researchers analysing and evaluating the current curriculum primary curriculum (developed in 1999), similarly attribute the failure of the curriculum to transform pedagogy and classroom learning experiences with the shortcomings of the implementation strategy put in place at the time (Sugrue, 2011; Murchan et al., 2009; Harford, 2010). The literature holds that the problem of curriculum implementation is complex and challenging to solve (Sahlberg, 2007) and policy aspirations can fail to be realised if "insufficient attention is paid to the range of inter-locking factors that affects implementation" (Walsh, 2016, 13). In order to ensure the success of future policy aspirations and ensure a measured approach to curriculum reform in Ireland, it is critical to take on board these lessons offered from previous curriculum reform efforts and also to explore contemporary research and thinking on how to solve the complex problem of curriculum enactment.

2.1.2 What is Lesson Study?

Lesson Study or 'jugyou kenkyuu' is a model of PD and learning, with its origins in Japanese elementary education, that has been credited with supporting significant changes in teaching (Takahashi and McDougal, 2016) and the effective implementation of new curriculum in Japan (Takahashi, 2014a). Outside of Japan, a number of jurisdictions have adopted Lesson Study in an attempt to replicate its success in transforming traditional teacher-centred instructional practice of mathematics to a more student-centred style of instruction that focuses on mathematical thinking and problem-solving (Hart et al., 2011).

Lesson Study is a teacher-orientated and teacher-directed process where curricular goals or areas for the development of children's learning are targeted (Puchner and Taylor, 2006; Saito and Atencio, 2013). Despite possible connotations associated with its title, lesson production and building banks of lessons are not the primary goals of Lesson Study (Lewis and Hurd, 2011). Rather, teachers engage in collaborative research or "the search for a

solution to a teaching-learning problem" (Takahashi and McDougal, 2016, 519) within the context of a professional community of enquiry (Widjaja, 2013).

There are a number of different levels of Lesson Study depending upon its purpose (Lewis and Takahashi, 2013; Takahashi and McDougal, 2016).

- *School-wide level Lesson Study*; where teachers from similar class/grade levels convene to plan and conduct one or two Research Lessons each year. Research Lessons are focused on school wide research themes
- *District level Lesson Study*; where local groups typically convene once a month and conduct semi-annual Research Lessons
- *Nationally designated research schools*; where teachers focus not only on teaching children but also studying curriculum and instructional methods for dissemination at national level. Research Lessons are then made public
- *Association sponsored Lesson Study*; where small interest groups regularly convene to discuss their practice. At conferences, members observe and discuss live Research Lessons based on theme chosen by members

Members of a Lesson Study group are typically from the same school or subject department but may also collaborate from different subject areas or schools (Fernandez, 2002; Lewis et al., 2006; Corcoran, 2007; Perry and Lewis, 2009). In conducting Lesson Study, teachers typically concentrate on a single discipline, e.g. mathematics. Internationally, school-wide level Lesson Study is the most common model of school-based PD (Yoshida, 1999). The purpose of school-based Lesson Study is to support teachers to gain new knowledge and insight for teaching and learning (Lewis and Hurd, 2011; Takahashi et al., 2013). In Japan, it has also been widely used to support the implementation of national curriculum (Murata and Takahashi, 2002).

Lesson Study has been extensively empirically tested and found to have positive effects on teaching and learning (Lewis et al., 2006; Lewis et al., 2009; Perry and Lewis 2010; Murata et al., 2012; Dudley, 2013). A randomised control trial of Lesson Study (Lewis and Perry, 2017) provides clear evidence that Lesson Study has a statistically significant impact on teachers' and students' mathematical knowledge. In fact, a meta-analysis review of 643 studies of mathematics PD indicated that this aforementioned study of Lesson Study was one of only two that showed a statistically significant impact on student learning (Gersten et al., 2014).

2.1.3 Literature Search Strategy

Relevant literature was sourced between 2015 and 2019 through a search of the following online databases: Academic Search Complete, British Education Index, EBSCO, Education Source, Emerald Insight and ERIC. The literature search was filtered primarily through the education field, and in general, the search was limited to peer-reviewed papers published from 2004 onwards. However, key articles published prior to this year were also included, as were non-peer reviewed national and international policy documents, research and curriculum including publications from the DES, NCCA and Teaching Council. The search string included combinations of the keywords *Lesson Study, professional development, curriculum reform, primary mathematics, curriculum policy, curriculum implementation, curriculum enactment, teacher education, teacher collaboration, school leadership, theory-driven evaluation, programme theory, theory of change, programme evaluation*. The same keywords were applied to searching the library catalogues of Lincoln University and Trinity College Dublin. This search suggested manuscripts and edited chapters in related books which were also useful.

2.2 The curriculum implementation gap

Curriculum is understood to be a socially constructed at policy and practice level by myriad partners through the process of negotiation and re-negotiation (Elliott 1998; Goodson 1998). Its enactment is evidenced by the interactions between teachers and children and ultimately the pedagogical decisions that teachers make as they transform and translate the curriculum into the unique context and learning environment of their classrooms; and in response to the unique needs, interests and abilities of the children they teach (Remillard and Heck, 2014)

Commented [TC1]: Correction 1

The curriculum implementation gap is described as "the silent pause between (curriculum) development and practice, where policy becomes implemented in theory before it is translated into practice some time later" (NCCA, 2007, 11). Sahlberg (2009) suggests that two essential aspects of curriculum change are necessary to close the implementation gap between intended and enacted curriculum - using 'change knowledge' in curriculum implementation and selecting appropriate implementing methods to help teachers and schools to change as expected. Change knowledge can be described as insights about the process of curriculum change. "While not a guarantee of success, neglecting to understand and appreciate the change process ensures implementation failure" (Sahlberg, 2009, 6).

Closing the gap between the intended and the implemented curriculum also requires that curriculum designers and policy makers select sophisticated implementation methods that take on board both internally constructed and externally imposed aspects of educational change (Smith and Southerland, 2006). PD activities need to appropriately equip teachers to learn new sets of pedagogical practices and develop an appreciation of the aims and goals of the curriculum reform (Bernardo and Mendoza, 2009).

2.2.1 Past evaluations and analyses of curriculum implementation in Ireland

A key criticism levelled at historical curriculum reform in Ireland has been the paucity of planning for curriculum implementation, particularly during the development phase; and lack of focus on methodical and continuous evaluation of implementation (Walsh, 2016). As primary curriculum reform in Ireland is imminent, it is useful to reflect on past evaluations and analyses of both curriculum implementation and also the in-service or PD provided to teachers in respect of the current primary curriculum, towards gaining an insight into the strengths to build upon and the areas for development in future policy endeavours.

The current Irish primary school curriculum was developed in 1999 and represented the first revision of curriculum in Ireland since 1971. The Irish primary curriculum was phased into schools over the implementation period 2000 to 2007, with concomitant in-service or PD support provided by the Primary Curriculum Support Programme (PCSP) over this period. An evaluation of the implementation of the current curriculum in schools (DES, 2005) indicated that despite the significant level of PD provided to teachers, a number of inconsistencies and weakness in implementation were evident, particularly teachers experiencing difficulties with methodologies related to a constructivist approach to teaching. Particular difficulties identified were an overemphasis on traditional, didactic and teacher directed learning; and a lack of collaborative and co-operative approaches to learning. An evaluation of the PCSP which attending the current curriculum was conducted by Murchan et al. (2005). This evaluation report offers potential insights into how the implementation strategy put in place at the time may have failed to produce the intended impact in classrooms.

Findings from an evaluation of curriculum implementation conducted in 2005 (Murchan et al., 2005) indicated that provision was well received by teachers overall. However, a number of weaknesses in the implementation strategy were identified in the evaluation

report (Murchan et al., 2005). The authors deemed provision insufficient to provide for the kind of critical reflection conducive to enhancing teacher learning; and to enable teachers to work with, and through, some of the methodologies and principles of the new curriculum. Provision was largely generic, with little choice afforded to schools and teachers in selecting the form or source of support to best meet their individual needs. Notwithstanding the successes of the implementation support programme to enhance teachers' knowledge and understanding of curriculum content, changes to teaching methodologies and understanding of implications of change for classroom practice were reportedly less evident.

Notably, these findings align strongly with the findings of the DES (2005, 25-33) implementation evaluation report, where weaknesses in implementation were largely attributed to teaching methodologies that were inconsistent with curriculum intentions as well as an overemphasis on out-dated pedagogical approaches (Murchan et al., 2005). Two key recommendations put forward by the evaluation report (Ibid) were that (i) schools should reflect a culture whereby teachers regularly enlist the support of peers to help them observe and reflect on practice; and (ii) strategies should be put in place to foster a sense of ownership of PD amongst teachers. These recommendations are in keeping with provisions in The Education Act (GOI, 1998 10) which states that "schools should take a greater responsibility for the PD of staff members".

2.2.2 The bridge between policy and practice

There is growing consensus among contemporary thinkers (Callan, 2006; Sahlberg, 2007) that teachers and schools are key to the actualisation of change and reforms, acting as the bridge between policy and practice; between aspiration and reality; and between the intended curriculum and the actual lived experience of curriculum. In synthesising the literature, it is useful to think about educational change in terms of having internal and external dimensions. Teachers' beliefs and backgrounds strongly impact how they implement curriculum, and consequently can conflict substantially with the intentions of reformers (Ball and Cohen, 1996; Remillard, 2000). Reynolds (2007) posit that teachers' behaviour and practice are influenced by their underlying beliefs, attitudes and values. For Walsh (2016), successful change becomes a reality only when new practices are understood and internalised, and subsequently assimilated with teachers' existing attitudes and practices. Changing internal dimensions, such as teachers' thoughts, beliefs and

perspectives are a prerequisite to shaping or modifying classroom practice (Harris, 2003; Hopkins and Reynolds, 2001).

On the other hand, external or contextual factors such as environmental circumstances and organisational cultures are thought to be equally influential in educational reform (Jones, 1997; Gess-Newsome et al., 2003). Fullan (2003) and Sahlberg (2009) hold that schools are best placed and equipped to improve teaching and help pupils learn. Unfortunately, many curriculum reform processes seem to ignore this reality. Aho et al. (2006) suggest that recognising and acknowledging the capacity and potential for schools and teachers to lead the exchange of new teaching and learning ideas and practices is key to bridging the curriculum implementation gap. The literature supports the notion that a number of multi-layered elements have a critical impact on the change process, with Smith and Southerland (2006) believing that the key to understanding the disconnect between intended and implemented curriculum lies in the interaction between both dimensions.

2.2.3 Teacher beliefs as a conduit to curriculum reform

The literature suggests that teachers' personal theories and beliefs can be considered to act as a potential barrier to their understanding and acceptance of the reform movement, thereby impeding the possibility of substantive curricular and pedagogical change (Battista, 1994, 467). Researchers claim that teachers' beliefs or personal theories about teaching and learning also strongly inform their decision-making in terms of the teaching methods and strategies they adopt, as well as the feedback and information they elect to share with students (Laplante, 1997; Smith, 2005). Teachers' beliefs serve to guide teachers actions in the classroom (Clark and Peterson, 1986; Thompson, 1992; Cooney and Shealy, 1997) with research suggesting that what teachers believe about proposed changes influences the outcome of reform efforts (Sarason, 1996; Gregoire, 2003). As a consequence, enacted educational reform can be seen to be largely determined by teachers' ability to think differently and adopt new ideas about learning and instructions (Putnam et al., 1992). Unsurprisingly, this has also led to teachers being identified as "the root of the problem" in failed efforts at reform (Cohen and Ball, 1990, 233) whilst simultaneously labelled as "key agents of change" (Ibid). Notwithstanding, Sarason (1996) warns that ignoring the role of teachers in the process of change is likely to result in failed reform efforts.

Research findings support the notion that pedagogical and curricular decisions made by teachers are typically grounded in their perceptions and beliefs about appropriate practice,

however it is not necessarily the case that these beliefs are congruent with the tenets of reform (Laplante, 1997, Smith and Southerland, 2006). Enacting curriculum reform and changes requires teachers to adjust their professional norms and identities (Wallace and Priestley, 2011); their personal, professional and cultural beliefs (King, 2014); as well as their attitudes, motivation, philosophies, and practices (Evans 1996; Hargreaves and Fullan 2012). In short, it challenges the hearts and minds of teachers.

In recognition of the importance of teacher beliefs, studies have concentrated on understanding the relationship between teachers' personal theories and beliefs; and reform efforts (Laplante, 1997; Franke, et al., 1998). Influencing and modifying teachers' personal theories and beliefs about teaching and learning is thought to be problematic as they are well established by adulthood and thus deeply resistant to change (Pajares, 1992). Because teachers' personal theories and beliefs are deeply rooted in both emotional and intellectual terms, they have difficulty assimilating new ideas into existing theories and rather "seek to maintain them unless their beliefs are justifiably challenged" (Ibid, 321). Smith and Southerland (2006) found that where teachers do understand the messages of reform, the contradictory messages of various external reform tools may result in teachers choosing to disregard the proposed changes in terms of their own practice. Whereas Gregoire (2003), found that teachers may unintentionally modify reform messages to fit their existing beliefs despite believing they are implementing reforms as intended. Sarason (1996) goes further to suggest that when change is introduced, even if teachers are broadly supportive of proposed changes in theory, it is considerably more difficult to adopt these changes in practice. Correspondingly, other studies provide evidence to suggest that deeply held beliefs may conflict with beliefs and perceptions of what is appropriate curriculum and instruction and thus constrain teachers from adopting practices that are congruous with policy and reform messages (Abell and Smith, 1994; Southerland et al., 2003). In the absence of ownership of change, teachers may feign compliance or portray the perception of change to satisfy policymakers and external evaluators, while the reality of change to practice is minimal (Sarason 1990; Fullan, 1993).

2.2.4 Context matters

Research on educational reform efforts that concentrate on classroom teachers in the process of reform suggest a number of inconsistencies worth noting. Research found that while some teachers openly embraced reform-oriented practices (Crawford, 2000), others were either unable or reluctant to change their pedagogical practice to align more closely

with reform initiatives (Laplante, 1997; Yerrick et al., 1997; Davis, 2003). The literature has much to offer in explaining this inconsistency. As previously described, research suggests that teachers' personal theories and beliefs appear to strongly impact their inclination to modify their practices and adopt change ideas. However, the literature is also replete with research investigating other factors specific to teachers themselves. Factors such as subject knowledge, self-efficacy and openness to take risks associated with change have also been found to have a profound impact on reform efforts within individual classrooms (Cohen and Ball, 1990; Gess-Newsome, 1999). However, what the literature of reform efforts has historically undervalued and overlooked, is the influence of the local context to impact change (Fullan, 1991; Battista, 1994; Yee and Kirst, 1994; Windschitl, 2002).

Indeed, the contexts within which teachers live and work are considered to strongly impact and influence teachers' personal beliefs and theories about teaching and learning (Lumpe et al., 2000). Some studies suggest that the reluctance to change is contingent on more contextual factors such as school culture, support from leadership and availability of resources (Vesilind and Jones, 1998; Lynch, 2000). While Remillard (2005) attributes the failure of systems to achieve sustainable reform with the dominant culture of teachers teaching alone in isolated classrooms without opportunities to observe other teachers or reflect on their practice.

Smith and Southerland (2006, 400) note that context can be perceived differently, depending on the lens or framework through which it is viewed and is thus not necessarily "universally understood". Context is typically equated with physical setting, such as a classroom or school building. However, Lave (1991) suggests that it includes the social exchanges that occur within the physical setting and the dynamic of how the features of these settings in turn influence these interactions. These contextual factors could be considered to include the conditions of the classroom; the relationship between the school and the community; the educational priorities of the school; internal school policies, and the finances and resources available, among others (Jones, 1997). From this perspective, the contextual factors that could be considered most likely to influence pedagogical reform or change also include the socio-environmental circumstances and the personal interactions that support teachers to modify practice (Hargreaves, 1994; Bullough and Baughman, 1997; Firestone and Louis, 1999; Gregoire, 2003).

2.2.5 Teacher quality and professionalism

The quality of teaching is the most important in-school factor that affects student learning and achievement (Hargreaves and O'Connor, 2018). Teacher quality and professional learning play a critical role in bringing the intended curriculum to life in classrooms (Ó Ruairc, 2013). Professional learning and development are deliberate ways to improve and enhance the quality of teaching (OECD, 2005; Mourshed et al., 2010; Hargreaves and Fullan, 2012). While there is much research to support the notion that teacher learning and PD are critical to the success of educational reform (Guskey and Huberman, 1995; Ball and Cohen, 1999; Elmore, 2002), the role of PD in supporting and enhancing teacher professionalism and teachers' professional learning experiences is widely debated. This is particularly pertinent where studies point to the ineffectiveness of traditional, managerial top-down mandated PD to support the enactment of educational change in classrooms (Fung, 2000). In exploring this further within the wider body of literature on PD, it is useful to consider PD as both a pedagogical and policy construct (Kennedy, 2014, 690).

Given that curriculum reform is typically proceeded with teacher PD, reflecting on these periods of reform leads naturally to considering not only the PD models or experiences provided to teachers but also the wider political agendas within which these experiences have traditionally been situated (Kennedy, 2014). Sachs (2003) presents a dualistic perspective on professionalism which is useful for understanding the ideological and political driving forces that underpin PD policy agendas. On one hand there is managerial professionalism which espouses efficiency, compliance with policy and externally imposed accountability reflective of private sector values (Bottery, 2006); and democratic professionalism which conversely positions teachers as change agents and promotes collaboration, openness and social justice.

The dominant and prevailing reality of a managerial professionalism agenda in Ireland is underpinned in by The Education Act (GOI, 1998, Section 5) which holds teachers to external standards of accountability and performativity. This agenda is reflective of policy agendas internationally (Ball, 2003; Bottery, 2006; Sahlberg, 2007) and aligned to globalisation (King, 2014) where it is argued that there has been an "erosion or trust" within the system (Sachs, 2006, 4). Such managerial policy agendas have contributed to what Sugrue (2011, 6) calls "performity as a technology of control". Moreover, it is argued that these policy measures are present in a "climate of distrust "(Sachs, 2006, 4) and standardisation (Linsky and Lawrence, 2011; Sugrue, 2011) and consequently limit teacher autonomy, creativity and innovation (Crawford, 2009). This policy agenda has been

attributed to many unintended consequences such as increased privatisation of practice (Goos et al., 2007), limited access to new ideas (Hargreaves and Fullan, 1992), insufficient reflective practice (King, 2011) and narrowing of curriculum (Mathews, 2010). Gleeson (2010, 2012) argues that, owing to this historical culture of top-down reform, many teachers may lack the competence or confidence to enact new curriculum changes. In Ireland, the recent publication of Whole School Evaluation reports online (DES, 2015); the mandatory reporting of standardised test scores to parents (DES, 2011); proposed mandatory requirements of PD and potential links to registration (Teaching Council, 2016) might also be considered to compound these issues.

Fullan and Hargreaves (2016) hold that professional standards and top-down mandated teacher PD and evaluation are extremely weak methods of improving teaching quality where, as noted by other authors, professional learning and development are "often linked to measurable outcomes or achievements of teacher quality, performance, and impact" (Fullan and Hargreaves, 2016, 3). The difficulty, according to Kennedy (2014) and King (2014), is that it does not always result in improvements in terms of children's learning. It could be argued then that professionalism is less about what others want teachers to do (Evans, 2008) and more about what teachers actually do, that translates to improvements for children (Earley and Bubb, 2004; Evans, 2008).

On discussing current policy trends and issues in Irish curricular reform, Dr Harold Hislop (DES, 2013, speech transcript), Chief Inspector of the Dept of Education and Skills articulated the following vision.

> *"I (also) believe that the curricular change that we envisage and the increased levels of teacher and school autonomy implicit within them, pose challenges that touch upon the professionalism of teachers and the role and skills of school leaders. A truly research-based teaching profession will be one in which professional practice is constantly reviewed by teachers themselves as part of their everyday work. ….. it also means that peer-review, where professionals collaborate on examining and improving their practice will be at the heart of effective schools…."*

This presents a more contemporary vision of professionalism which is important to consider when envisaging the model of PD which will attend new curriculum developed in Ireland over the coming years, not least the imminent publication of a new primary mathematics curriculum into the Irish education system. Subsequently in 2016, Cosán, a new National Framework for Teachers' Learning in Ireland was established (Teaching Council, 2016). In

accordance with this vision, Cosán is based on the core values of professional autonomy; flexibility; relevance and quality; accessibility; acknowledgement and impact. It facilitates teachers to value their learning, and to prioritise learning that benefits them and their students. Furthermore, it gives teachers autonomy to plan their professional learning to take account of the changing needs of their students, and their own personal and professional needs.

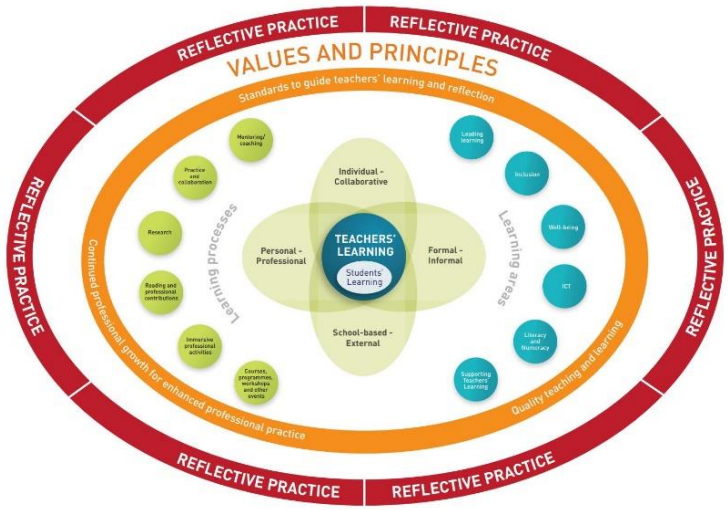


Figure 1. Cosán Framework for Teachers Learning, Teaching Council (2016, 28)

2.2.6 Teachers as agents of curriculum change

In many education systems, technical rational models of curriculum implementation are prevalent, placing the teacher in the role of "curriculum implementer" rather than "curriculum maker" (Clandinin and Connelly 1992, 361). In many cases, teachers' views and the ideas they bring to the processes of curriculum implementation are often overlooked (Lee and Ling, 2013). Concurrently, Dadds (1997, 31) critiques the "notion of delivery or 'teacher as technician' as a deficient and dangerous model for educational reform". Kennedy (2014, 691) asserts that despite the common policy approach for PD systems and programmes to tie teachers up in "bureaucratic, managerial knots that squeeze out autonomy and instead seek and reward compliance and uniformity", teachers can only become agents of change when they are afforded autonomy and agency.

Contrastingly, contemporary democratic professionalism agendas emphasise "collaborative, cooperative action between teachers and other educational stakeholders" (Sachs, 2001, 153) and has long been advocated within the literature (Hargreaves, 1994). This agenda holds that it is through dedicated opportunities for self-reflection and action, that teachers learn how to question, analyse and change (Darling-Hammond and McLaughlin, 1995) in a process which is both contextualised and directly relevant to their own experience (NCCA, 2007). For reforms to be successful, teachers need time to mediate and make sense of new policy ideas (Spillane et al., 2002) and make decisions based on their understanding and unique complexities of their context (Scheker, 2009).

The more recent literature on whole system reform in education (Hargreaves and Fullan, 2012; Fullan and Hargreaves, 2016) has given rise to a new term that encapsulates this agenda, namely "collaborative professionalism" (Fullan and Hargreaves, 2016, 2). Collaborative professionalism goes further to recognise and build on the strengths of individual teachers to support professional growth and development; promotes calls for space and time for teachers to lead each other authentically; value the expertise and inclusion of all voices, perspectives and roles; and advocate for professional practices informed by research; as well as evidence and knowledge derived from the strengths, needs and interests of students and education professionals. This new conceptualisation of professionalism offers insights into how PD can be mobilised to influence the teaching profession and complements current PD policy agendas in Ireland to effect whole system reform (Teaching Council, 2016).

New professionalism agendas for Irish teachers, such as those implicit in Cosán (Teaching Council, 2016) [See figure 1] set the tone for future curriculum reform efforts in Ireland by placing teacher quality and collaborative PD at the centre of reform and positioning teachers as curriculum-instructional gatekeepers (Thornton, 1991, 2005) who "ultimately bear responsibility for implementing curriculum reform" (Bybee, 1993, 233). Within this perspective of professionalism, teachers are key agents of curriculum change because it is recognised that it is ultimately their decisions and actions that determine how policy and curriculum translate into practice (Coburn, 2006; Honig, 2006, as cited in Scheker, 2009).

2.3 Teacher professional learning and development

Numerous authors have highlighted the importance of teacher PD during the implementation of curriculum reforms (Louden, 1991; Desforges, 1995; Fullan, 2007) so

that new knowledge and skills can be enacted and positively impact on students' learning (Hargreaves, 2000; Verloop, 2001; Day, 2002; Opfer and Pedder, 2011). Teacher PD is considered the most critical mediating factor to ensure that education reform translates into the intended changes in student learning and achievement (Guskey and Huberman, 1995; Ball and Cohen, 1999; Elmore, 2002). This is because PD is thought to bring broad externally validated reform ideas in contact with specific contextualised teaching and learning situations (Elmore, 2006). The selection of appropriate implementation models and activities is critical for teachers to adopt new curriculum reforms and incorporate new curriculum ideas and messages into their practice (Bernardo and Mendoza, 2009).

In particular, Dadds (1997) argues for the need to select models of PD that attend to (i) the development of teachers' understanding of learning; (ii) teacher agency and professional judgement; and (iii) confidence to cultivate inner beliefs and expertise as a basis for teaching and adopting external initiatives. In terms of supporting the enactment of education reform, the National Research Council (1996, 2000) recommends that teacher PD activities should emphasise and promote teachers' explicit engagement with the actual description of reform represented in reform materials. Given the imperative within the literature, for policy makers to select appropriate implementation methods to attend curriculum reforms (Sahlberg, 2009), it is important to gain insights into PD provision for teachers following past revisions of the primary curriculum as well as explore further the literature to expose the elements of effective PD for supporting curriculum reform and change.

2.3.1 Insights from professional development provision in the past

In Ireland, the findings from evaluations of curriculum implementation (DES, 2005; NCCA, 2005) strongly align with evaluations and analyses of the large-scale centralised in-service programme provided to teachers following the dissemination of the 1999 primary curriculum (Sugrue, 2002, 2011; Murchan et al., 2009; Harford, 2010). Murchan et al. (2009) found that the in-service programme provided to teachers at the time resulted in modest and varied implementation of the curriculum, with an emphasis on individual planning over sharing of practice.

Little (1993) holds that given the complexity of classrooms and improving student learning, typical models of PD, which traditionally have focused on transmitting a pre-determined set of skills from expert to teacher, is not adequate. It is suggested that such traditional

'transmissive' models of PD might, as cautioned by Murchan et al. (2009, 468) "lead to a culture whereby teachers feel incapable of embracing reforms and adjusting professional practice without first receiving externally provided professional development".

In contrast, an evaluation of curriculum implementation by the Department of Education and Skills [formerly Department of Education and Science] (2005) indicated that the schools that were most successful did not rely on external support services, but rather took ownership of the curriculum implementation process themselves. These schools had developed the capacity of their staff to lead and manage curriculum change and work towards a shared vision. Similarly, Sugrue (2011) concluded that successful curriculum implementation requires more school-based PD, and schools "need to take more responsibility for the professional learning of staff." In contrast to traditional models of PD, contemporary 'transformative' models of PDs are characterised as a process of problem-identification by professionals and subsequent activity, "where the subsequent activity involves enquiring into one's own practice and understanding more about other practice, perhaps through engagement with research" (Kennedy, 2014, 7).

2.3.2 Effective and meaningful professional development

There is a large body of literature that focuses on characteristics of, and conditions for, effective PD in general (Cordingley et al., 2003, 2005, 2007; Timperley et al., 2007). Darling-Hammond and McLaughlin (2011) stressed that PD must encourage teachers to build upon and continually improve their pedagogical knowledge. Maskit (2011) posits that PD ought to be a lifelong and a dynamic process that is grounded in everyday teaching experience.

Narrowing the literature search to focus on PD that is specifically effective to support the implementation of curriculum reform, offers a number of insights. Fullan (1996, 420) posits that when implementing reform ideas "clarity must be achieved on the receiving end more than on the delivery end". In the past, teachers have expressed substantial uncertainty and frustration in response to curriculum reform efforts with the result of teachers receiving contradictory messages and lacking a clear understanding of what is required of them in terms of pedagogical modifications (Smith and Southerland, 2006, 417-8). Correspondingly, in *An Evaluation of Curriculum Implementation in Primary Schools* (DES, 2005, 1) it was stated that teachers "require a thorough understanding of the meaning of educational change before there is an acceptance and adoption of new programmes".

Remillard (2000) and Hanley and Torrance (2011) hold that in order for teachers to engage meaningfully with new curriculum and incorporate changes to their practice, they must not only familiarise themselves with new curriculum messages and materials but they also need to see the curriculum enacted. Furthermore, teachers require scaffolded and repeated opportunities, over time, with other teachers who are focusing on shared and common issues (Garet et al., 2001) in order that they may contend with the key messages of reform and change, and to allow them to work through the implications of same for their own teaching practices (Smith and Southerland, 2006).

Spillane's (1999) research on the implementation of mathematics reform offer insights into the kind of school context and interactions or 'zones of enactment' that support teachers to understand and integrate reform ideas into their existing practice. For Spillane (Ibid), these 'zones of enactment' are crucial in supporting teachers to enact proposed reforms and changes to their practice. To be successful, these zones of enactment must be social rather than individualistic; they must provide opportunities for rich discourse and deliberation on reform ideas with their peers and reform experts; and they must be supported by materials that guide their "sense-making" (Spillane et al., 2002, 392). In accordance with these recommendations, it holds that for PD to be effective it ought to be context-embedded, sustained, collaborative, and linked to practice (Guskey, 2000; Darling-Hammond and Richardson, 2009; Desimone, 2009; O'Sullivan, 2011; Teaching Council, 2016).

2.3.3 Teacher collaboration

PD research increasingly refers to the importance of considering the social dimension of learning for teachers, including collaborative learning, communication and sharing of knowledge (Hord, 2004; Grossman et al., 2001; McLaughlin and Talbert, 2006). Fullan and Hargreaves (1991) hold that teacher collaboration is fundamental to supporting pedagogical and curriculum change. It is suggested that acquiring knowledge through the processes of collaborations and social exchange in a safe learning community environment can result in a powerful transformation for teachers (Gutierez, 2015a), where they can become active participants who learn directly from their own teaching practices (Shriki and Movshovitz-Hadar, 2011).

As a model for supporting curriculum enactment, collaborative learning and professional learning communities are known to have substantial impact on teachers' professional learning and development (Campbell et al., 2016) and has gathered acclaim in recent times

as an effective tool to support education reform at individual, school and system level (Stoll et al., 2006), particularly as they help teachers to mediate between educational policies and the realities of the classroom (Louis and Marks, 1998; Stoll et al., 2006; Dooner et al., 2008). Research on professional learning communities or teacher communities show that they provide an ongoing space for professional learning and social structures for professional collaboration and collegiality. When structures are provided in schools to facilitate teacher collaboration, teachers are provided with a means to engage with national educational and curricular policies in the context of their own schools and realities (Guskey, 2002; McLaughlin and Talbert, 2006; Dooner et al., 2008; Darling-Hammond and McLaughlin, 2011; Ní Shúilleabháin, 2013); and to attempt and reflect on new approaches to teaching and learning that are relevant to their own context (Vescio et al., 2008; Hargreaves and Fullan, 2012; Dogan et al., 2015). Furthermore, through teamwork and dispersed leadership, teachers tend to build their professional capacity to solve problems and make decisions (Ní Shúilleabháin, 2013), as well as being assisted to reinvent their professional norms and identities (Lieberman, 2009).

Notwithstanding the commendations made in the literature for teacher collaboration, Kennedy (2014) offers a strong caution that contrived collaboration to promote externally imposed interests is not confused with PD that is fundamentally teacher and student driven. Equally, Ó Ruairc (2013) cautions that strictly mandated time for teachers to collaborate, reflect and plan holds that potential to become fragmented and undermine the very purpose which it sets out to achieve.

2.3.4 Perspectives of learning with the new primary mathematics curriculum

The rationale to develop a new primary mathematics curriculum in Ireland arises from contemporary thinking and research that offer fresh insights into "how children learn and why they learn in particular circumstances" (NCCA, 2016b, 2) and overall represents "a transformation in how mathematics itself, the learning of mathematics and concomitant pedagogy are conceived" (Dooley, 2019, 24). Franke et al. (1998) holds that in addition to supplying new materials and procedures to teachers as part of curriculum change, generating sustainable educational change also involves developing teachers' epistemological perspectives of what it means to learn as well as their conceptions of learning.

In contrast to the existing primary mathematics curriculum, the new curriculum places a greater emphasis on both social processes and individual sense making as central elements in the learning of mathematics (Ernest, 1991), where new learning is constructed by the learner and continuously tested and refined through further experience and social interaction (Fung 2000). Accordingly, critical goals of the new primary mathematics curriculum are to support the development of children's mathematical proficiency through "active participation; engagement in mathematization[1]; to support children to build positive identities of themselves as mathematicians and through working collaboratively with others" (NCCA, 2016b, 3). This epistemological shift towards more sociocultural learning experiences for children reflects reform efforts in mathematics internationally (Dunphy et al., 2014) and has led to the creation of mathematics curricula that promotes collaborative learning, focuses on strengthening participation and mathematical knowledge of all students; as well as functioning as instructional guides that promote problem solving, communication, reasoning, and creating mathematical connections (Senk and Thompson, 2003).

In line with sociocultural perspectives of children's learning, research is also increasingly highlighting the social dimensions for the professional learning and development of teachers (Grossman et al., 2001; Hord, 2004; Fullan and Hargreaves, 2016). Indeed, Sahlberg (2009, 3) suggests that "if implementation of curriculum or any other pedagogic change in schools is seen from the system thinkers' point of view, then it should be understood as an organisation's learning process as much as an individuals'[sic] learning process". In a related way, Martin (1993, 6) reasons that supporting teachers to "engage with and understand their own professional learning as a process of individual and social construction will help them to understand the learning of their students". This perspective suggests that the new primary mathematics curriculum and the attendant PD model to support its enactment in the classroom might benefit from a congruent approach to facilitating new learning for both children and their teachers.

[1] Mathematization involves children interpreting and expressing their everyday experiences in mathematical form and analysing real world problems in a mathematical way through engaging in key processes such as connecting, communicating, reasoning, argumentation, justifying, representing, problem-solving and generalising (Treffers and Beishuizen, 1999; Ginsburg, 2009, as cited in NCCA, 2016b).

2.3.5 Supporting enactment of the new primary mathematics curriculum

The Irish Government Action Plan (DES, 2017a) acknowledges that the provision of effective PD is vital to realising curriculum reforms in Irish education. PD is a vital means to support the enactment of the new curriculum, as highlighted in the background paper and brief for the development of the new impending primary mathematics curriculum (NCCA, 2016b). This background paper acknowledges the significant influence that PD has on successful curriculum implementation and spotlights the importance that PD provision that will attend the new curriculum is effective and research-based.

Given the critical role of PD in mediating policy and practice (Guskey and Huberman, 1995; Guskey, 2001), and the recommendations put forward in various research reports and evaluations (Murchan et al., 2005, 2009; Sugrue, 2011), it is critical that an appropriate, research-based, PD model attends the new primary mathematics curriculum. Sahlberg (2009) holds that in-service training of teachers is not sufficient to bridge the implementation gap between the intended and implemented curriculum, rather, a specific approach is needed. In this case, "helping teachers to create professional learning communities and schools to learn from each other are recommended approaches" (Ibid, 8). Teachers cannot be expected to implement new curriculum material without a suitable structure for supporting their use of this material (Krupa, 2012) and so, it is important that they are provided with PD supports and opportunities to engage meaningfully with any reforms they are being asked to implement (Remillard and Bryans, 2004; Charalambos and Philippou, 2010; Hanley and Torrance, 2011). Given that transitioning to new ways of teaching and learning mathematics as part of curriculum reforms is challenging for many teachers (Ziebarth, 2003), it holds that for substantive teacher change to occur, the new primary mathematics curriculum needs to be attended by a robust and sustained PD programme (Dooley, 2019).

The extant research explored in this chapter offers clear insights into the conditions and approaches that are incumbent for PD to be successful in supporting teachers to enact new curriculum, not least the need for appropriate space and time to be provided to teachers to collaborate and familiarise themselves with new curriculum materials and messages, and to see curriculum enacted in their own context. Furthermore, the National Research Council (1996, 2000) recommends that teacher PD activities should emphasise teachers' direct engagement with the actual description of reform represented in reform materials.

2.3.6 Key changes and implications for professional development

As outlined, the literature suggests the need for an alternative model of PD to support teachers to implement future curricula in a different way (Evans, 1996; Hargreaves and Fullan, 2012), to address learning from previous curriculum reform efforts and to reflect the key shifts that have occurred in curriculum policy and practice

The following table summarises the key shifts reflected in changes to curriculum policy and practice, as evident from the literature.

Table 1. Summary of key shifts in curriculum policy and practice

	From	**To**
Approach to curriculum reform	Managerial	Democratic
Curriculum change drivers	External policy agendas and 'experts'	Teacher designed, context focused, evidence-based.
Role of teacher	Curriculum implementer	Curriculum maker
Role of context and accountability	Individualistic External evaluation	Social collaboration Teacher and school autonomy
Role of curriculum	Technical document	Guide for practice
Professional development model	Generic model for all schools in Ireland Transmissive Focus on teacher learning Regional-based	Individualised to meet specific needs of teachers and schools. Transformative Focus on student learning School-based Collaborative

The trajectory of policy and practice presented in this table has considerable implications for stakeholders of curriculum reform and implementation and gives rise to the need to explore new paradigms for teacher professional learning and development in Ireland to support these changes. In exploring new approaches, Wiliam (2014, 32) states that many PD activities have tended to focus on "fads with little research evidence in their support". As such, empirical research is needed to give weight to different PD approaches and models, and ultimately inform decisions about the model of PD that will attend the new impeding primary mathematics curriculum.

Furthermore, it is noteworthy that many studies detail critical weaknesses in the relationship between PD and children's learning outcomes. Yoon et al. (2007) conducted one of the largest and most inclusive syntheses of research on how PD affects learning achievement. This meta-analysis of over 1,300 studies highlighted the difficulty and implausibility of translating PD into children's learning outcomes despite intuitive and rationale connections. This in itself raises concerns as, characteristically, PD is a systematic effort to bring about change and improvement in the classroom practices of teachers, both in terms of their attitudes and beliefs, as well as in terms of learning outcomes for children (Guskey, 2002). Furthermore, a systematic review of effective PD in mathematics by Gersten and colleagues in 2014 highlighted the paucity of interventions to determine any significant impact on children's learning in mathematics. Therefore, in looking at different approaches and models of PD to attend the new primary mathematics curriculum, it would be beneficial to include a focus on the impact on children's learning outcomes.

2.4 Lesson Study as a support for curriculum enactment

As introduced in sub-section 2.1.2, Lesson Study is a model of PD originating in Japan and based on the Japanese practice, jugyou kenkyuu which translates as instructions or lessons (jugyou); and research or study (kenkyuu). Whilst there is not a universally accepted definition of Lesson Study (Seleznyov, 2018), in broad terms, Lesson Study is a collaborative professional learning process where a group of teachers focus on the development of, enactment and observation of, and refinement and analysis of classroom Research Lessons. As Lesson Study has been adopted in different contexts, so too has it been adapted (Wood, 2018). Notwithstanding the numerous variations of Lesson Study found in international contexts (Norwich, 2018), there are features of Lesson Study which distinguish it from other types of PD. Moreover, these features have been identified in the literature as contributing to the implementation of curriculum reform in a number of different ways. A key challenge identified in the research underpinning the new primary mathematics curriculum (NCCA, 2016b) will be supporting Irish primary teachers to adapt their practice to incorporate the pedagogical implications and conceptual perspectives inherent in the new primary mathematics curriculum. Lesson Study has been identified as a key means by which teachers may be facilitated to enact curriculum reform (Takahashi, 2014a; Ní Shúilleabháin and Seery, 2017); and as a rich site for the kind of professional learning and development that is conducive to bringing the new primary mathematics curriculum to life in Irish primary classrooms (Dooley, 2019).

2.4.1 Distinguishing features of Lesson Study

Repeated cycles of professional learning and development

A Lesson Study cycle consists of six steps [see Figure 1] where teachers collaborate as professionals to (i) determine a clear research purpose or theme based on desired outcomes for children's learning, (ii) study curriculum and pedagogy as groundwork for lesson design, (iii) develop a lesson research proposal with identified learning goals to address the research theme, (iv) teach and observe a live Research Lesson, (v) share data and discuss implications for future lessons (vi) work with a Knowledgeable Other to summarise learning, make connections and decide next steps (Takahashi and McDougal, 2016). This process encourages considered reflections through repeated cycles of planning, observation and feedback which supports teachers to reflect on their pedagogical practices (Lewis et al., 2009; Corcoran, 2011a).

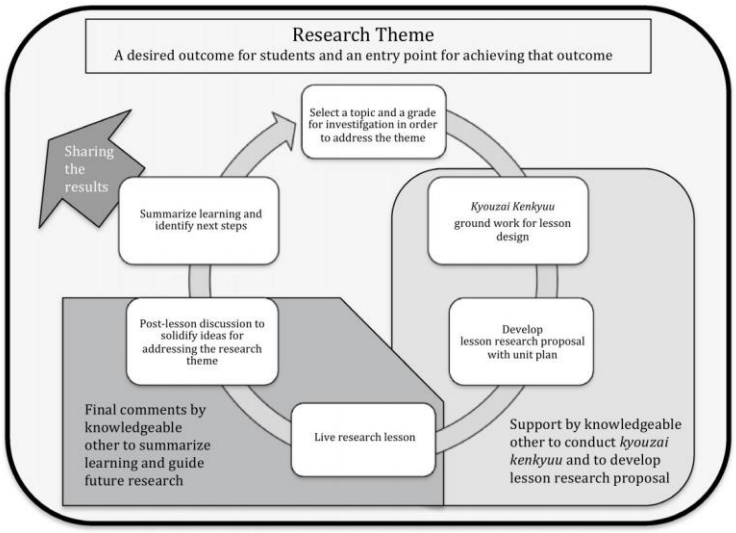


Figure 2. Lesson Study cycle (Takahashi and McDougal, 2016)

Rather than being considered as a professional learning and development event, Lesson Study is considered a career-long approach to professional learning and development (Wood, 2018). The merit of teachers engaging in repeated cycles of professional learning and development (study, trial in the classroom, reflection, refinement, and retrial in the

classroom) as a means to improve classroom practice has been highlighted in the literature (Fennema et al., 1996; Clarke and Hollingsworth, 2002; Jaberg et al., 2002). This is well illustrated in a study by Olander and Sandberg (2013) which showed increasing sophistication in teachers' teaching with each repeated cycles of Lesson Study and which resulted in increasing improvements in children's learning achievement.

Established research goals and kyozai kenkyu

Each cycle begins with collaborative research themes or goals for teaching, related to long-term goals for children's learning (Lewis, 2002). The research theme is usually a broad goal that is compelling to teachers from all grade level and points of interest such as "building desire to learning, building responsibility and initiative to learn and understanding subject matter" (Fernandez and Yoshida, 2004, 56). Teachers then engage in kyouzai kenkyuu, which translates literally as 'instructional materials'. This is a key component of Lesson Study that focuses on the study of curriculum materials and academic content curriculum. This process becomes the foundation on which to examine and improve their practices through planning, conducting, observing, and reflecting on Research Lessons designed to bring individual lesson goals and plans to life and inform the design of future lessons (Takahashi and Yoshida, 2004; Lewis et al., 2006; Murata et al., 2012).

Collaboration around the Research Lesson

Research Lessons are the heart of Lesson Study as they provide the space to plan for children's lived experiences of learning (Lee and Ling, 2013) and carefully observe student's learning during live lessons (Lewis, 2005) in the classroom environment. By facilitating teachers to work collaboratively to plan, teach and analyse the Research Lesson, Lesson Study builds a professional learning community where teachers can improve their knowledge of content, teaching, and students (Coenders and Verhoef, 2019). Knowledgeable Others play a critical role in helping Lesson Study to be effective. Knowledgeable Others are people with extensive knowledge of both the curriculum goal topic and Lesson Study itself. Support from Knowledgeable Others help to deepen teachers' knowledge of content and accomplishment of PD goals (Takahashi and McDougal, 2016). Well-designed Research Lessons provide a space for teachers to bring to life their understanding of good instruction, based on careful, collaborative study of existing

materials and research (Lewis et al., 2006) with their teaching colleagues and a Knowledgeable Other. In addition to support from colleagues and Knowledgeable Others, Lesson Study is also contingent on appropriate support from school leadership. The degree to which Lesson Study can be successful and the willingness of teachers to engage in Lesson Study in their schools to improve practice without the support of senior school management and leadership has been questioned (Tan-Chia et al., 2013).

The product of the Research Lesson is less important than the process of teachers collaborating and conversing with one another on curriculum and pedagogy (Gutierez, 2015a). Through the social exchanges that occur in the Lesson Study process, teachers are facilitated to collaborate and converse on curriculum and pedagogy; and to engage in deep and grounded reflection and discourse on curriculum and the complex activities of teaching. In this way, Lesson Study complements learning as a social and situated process, with teachers' own classrooms and context considered the optimal site for professional learning and development (Gutierez, 2015a). For Ermeling (2010), improvements in teachers' practices result from teachers collaborating together, and with Knowledgeable Others, around the common goal of making connections between the Research Lesson and children's learning outcomes. Indeed, it is through the careful observation and analysis of instruction in the Research Lesson that teachers are enabled to strengthen their professional knowledge and insights and use this directly in their teaching; as well as adapt and improve on their teaching (Hiebert et al., 2002). Moreover, it provides a forum for teachers, researchers and school leaders to see how their ideas cohere or differ and to identify points for future discussion and development. In doing so, accountability to colleagues, focus on student learning, and continued efforts to improve are natural and integral parts of the teacher learning community that develops in Lesson Study (Lewis and Hurd, 2011, 8) and as such echoes the principles of collaborative professionalism which Fullan and Hargreaves (2016) advocate as having the greatest potential in leading and supporting educational change.

2.4.2 Lesson Study as a means to address the curriculum implementation gap

As evidenced in the analysis of reviews and evaluations of curriculum implementation in Ireland outlined previously [See sub-section 2.3.5 - Sugrue, 2002; Murchan et al., 2005, 2009; Harford, 2010], traditional approaches to PD are not addressing the divide between the intended and implemented curriculum (Fetters et al., 2002). Curriculum reform requires that teachers build an awareness of new curriculum ideas. While curriculum documents

and materials, information seminars and inspection of curriculum enactment are important steps; alone, these are not sufficient to ensure that professional learning will translate into real and meaningful learning as intended by the curriculum. In order for curriculum enactment to be successful, PD must fulfil two critical purposes, it must support teachers to engage with the curriculum materials and encourage change to traditional classroom practices (Remillard, 2000). In order to engage meaningfully with new curriculum and enact reform in their classrooms, Remillard (2000) and Hanley and Torrance (2011) suggest that teachers must be allowed to familiarise themselves with curriculum messages and materials as well as see the curriculum enacted. Lesson Study is a model of PD which orientates around these principles; and as such, enables "a process which makes this possible" (Lee and Ling, 2013, 204).

A number of studies have demonstrated the merit of Lesson Study as a tool to support and catalyse curriculum change; and ensure greater congruency between reform goals and the lived classroom experience (Takahashi, 2014a; Ní Shúilleabháin and Seery, 2017). Lewis and Takahashi (2013), identify core transferable elements of Lesson Study used to support the enactment of curriculum in Japan that can be adopted in any jurisdiction, such as the use of live Research Lessons; the interchange among teachers of varying experience; the leveraging of regional and national expertise; dissemination and sharing of practice; class-level collaboration; and a period to try out new curriculum standards before enactment is mandated. In international contexts, Lesson Study has been used to support education reforms such as in China (Fan Yang, 2013), the US (Takahashi et al., 2013), Singapore (Tan-Chia et al., 2013) and Sweden (Olander and Sandberg, 2013). In support of mathematics curriculum reform, Lesson Study based practices have been used to facilitate major curriculum changes in Japan such as incorporate teaching of mathematics through problem-solving (Lewis and Takahashi, 2013). In the U.S., it has also been shown to enhance teachers' PD to teach mathematics (Lewis and Tsuchida, 1997; Stigler and Hiebert, 1999). In Ireland, Lesson Study was found to positively impact post-primary mathematics teachers' pedagogical practices and beliefs on student learning, as it related to newly introduced curriculum (Ní Shúilleabháin and Seery, 2017).

2.4.3 Instructional improvement and alignment

Given the importance of providing opportunities for teachers to decontextualise and recontextualise reform ideas for their own practice (Spillane, 1999), there are a number of core elements of Lesson Study that can be considered to support the enactment of

curriculum reform. The Research Lesson brings together the ideas of teachers, researchers and policy makers; and provides teachers with an opportunity to gather data, specific to their own context, and use this to inform improvement (Lewis and Hurd, 2011). Moreover, teachers' convictions about the key tenets central to learning and pedagogy can be tested, challenged and explored in the Research Lesson space (Ibid), resulting in new practices which align with curriculum enactment as intended by reformers. Similarly, in the context of kyozai kenkyu, teachers' understanding of reform intentions and new curriculum can be debated and refined, and in turn can be more meaningfully assimilated (Lewis and Takahashi, 2013).

Lewis et al. (2006, 5) suggest that Lesson Study leads to instruction improvement by attending to teachers' knowledge for teaching mathematics, their commitment and motivation to improve, their connection and accountability to their colleagues, and the development of learning resources and tools that concomitantly promote student learning and support collegial learning.

For Lewis, Perry and Hurd (2009, 286), Lesson Study illuminates teachers' ideas about pedagogy and their understanding of children's thinking, and in doing so "enabling teachers to encounter new or different ideas, and to refine their knowledge". Within this professional learning context, Ní Shúilleabháin (2015) holds that knowledge building and meaning making occurs around new reform ideas. Lee and Ling (2013) hold that, in particular, Lesson Study helps to facilitate policy-driven shifts that aim to move classroom practices from 'teaching as telling' to 'teaching as understanding'. The development of less teacher-centred approaches as a result of engaging with Lesson Study was also determined by Cajkler et al., (2014).

2.4.4 Sense of collaboration and community

In addition to improvements in teachers' knowledge and instruction, Lewis et al. (2009) also found that Lesson Study supported teachers to develop a sense of community such that the introduction of reforms was perceived to be more manageable. These findings were echoed in a survey of 125 Japanese teachers conducted by Murata et al., (2012) who found that Lesson Study provides opportunities for better communication among stakeholders by presenting concrete classroom teaching examples of particular educational ideas or issues, thus "minimising the gap among theory, research and practice" (Ibid, 2).

In more general terms, Lesson Study has been demonstrated to create a stronger sense of teacher community among its participants (Cajkler et al., 2014). According to Lewis and Hurd (2011), Lesson Study fosters teacher's intrinsic motivation to continue to improve not only their own teaching but also that of their colleagues. Moreover, compared with teachers who do not participate, teacher participants in Lesson Study are more likely to report that learning with colleagues is effective and enjoyable; and they are more inclined to collaborate regularly with their colleagues as a result (Lewis and Perry, 2010).

2.4.5 Shared language and understanding

Lee and Ling (2013) proffer that for reforms efforts to take hold in schools and result in meaningful change, agents of educational reform should acknowledge and take cognisance of the existence of teacher's native concepts and practical wisdom passed down from generations. In a study seeking to examine how Chinese teachers engaged with new curriculum reform with Lesson Study, the researcher observed that on encountering the external reform, the teachers used their native concepts to understand, as well as to express their understanding of the reform (Fan Yang, 2013). This study found that Lesson Study helped to remedy this resistance by providing a space for teachers' use their native discourse and in doing so, "make transparent their own tacit practical knowledge" (Ibid, 234); and assisted the teachers to move from fixed ideas to explore alternative ideas. Correspondingly, Lewis and Hurd (2011) hold that in Lesson Study, teachers develop a common language that they use to collectively identify and tackle problems. Moreover, through Lesson Study teachers reveal and share their interpretations of curriculum theories and terminology, and collaborate to understand how new ideas might best be manifest in the classroom.

According to Fan Yang (2013), it is through the planning and execution of Research Lessons in Lesson Study that space is provided for native discourse, hidden belief systems and practical wisdom to be explored and contextualised towards the development of new understandings, meaning making and knowledge building. Lee and Ling (2013, 205) go further to suggest that "it is *only* through this collaborative discourse among teachers, supported by Knowledgeable Others, that reform ideas can take root in classrooms and bring about lasting change". This closely aligns with what Little (2003) describes as the decontextualization and recontextualization of an external reform where teachers were found to decontextualise external or new reform curricula and ideas and recontextualise these in terms of their practice and pedagogy.

2.4.6 Improving learning outcomes for children

There is also a growing body of evidence that Lesson Study improves student learning (Lewis, Perry and Murata, 2006; Lewis, Perry and Hurd, 2009; Foster and Poppers, 2009; Saunders et al., 2009; Perry and Lewis 2010; Waterman, 2011; Lewis and Perry, 2017. In a study designed to investigate the use of Lesson Study to support the implementation of Teaching Through Problem-Solving, an initiative of the Common Core State Standards (CCSS) in the U.S. (Takahashi, Lewis and Perry, 2013), the researchers found that Lesson Study enabled teachers to collaboratively investigate the kinds of teaching that would enhance children's learning outcomes in mathematics. Participants reported that Research Lessons in Lesson Study provided a "natural way to connect new instructional ideas to one's own practice" (Ibid, 249) and enabled them to articulate "their own long-term goals for student development as mathematics learners" (Ibid, 247). Similarly, a study conducted by Tan-Chia et al. (2013) described how Lesson Study was used to help Singaporean teachers to implement specific language development goals from the 2010 Revised National English Language Syllabus. Findings from this study (Tan-Chia et al., 2013) indicated that Lesson Study resulted in improved engagement and increased collaborative participation among students. Some studies also offer plausible explanations as to how and why Lesson Study improves student learning in mathematics - through increases in teachers' content and pedagogical knowledge for teaching mathematics (Ní Shúilleabháin, 2016); a focus on student thinking and discourse (Yilmaz et al., 2017) and making students' learning visible (Cerbin and Kopp, 2006).

Of particular interest to this study, Lesson Study has been demonstrated as one of a small few models of PD that results in statistically significant positive effects on student mathematical proficiency (Lewis and Perry, 2011). A systematic review of effective PD in mathematics (Gersten et al., 2014) highlighted the paucity of interventions to determine significant impact on learning in mathematics. Out of 643 PD approaches related to math in grades K–12 (US) (for children typically aged 5 to 18 years old), only five were deemed to have met rigorous WWC evidence standards[2] for causal validity. Of the five, only two PD

[2] WWC or What Works Clearinghouse is a widely cited repository of evidence on "what works" in education, launched in 2003 and hosted by the Institute of Education Sciences' (IES) - an independent, non-partisan statistics, research, and evaluation arm of the U.S. Department of Education.

interventions were found to have statistically significant positive effects on students' mathematical proficiency, one of which was Lesson Study (Lewis and Perry, 2017).

2.4.7 Supporting enactment of the new Irish primary mathematics curriculum

A new primary mathematics curriculum is currently in development. Given past evaluations and analyses of primary curriculum implementation in Ireland [See sub-section 2.2.1], it is important that key learning from this period is attended to and that appropriate measures are taken to inform planning for implementation of future curriculum (Walsh, 2016), in this case the publication of the new primary mathematics curriculum, anticipated for 2021.

The selection of Lesson Study as a model of PD to support teachers to actualise the new primary mathematics curriculum is supported by the growing evidence base to proffer the credibility of Lesson Study, both as a model of PD (Cavey and Berenson, 2005; Hart, 2009; Lewis, Perry and Hurd, 2009; Matthews, Finken and Hlas, 2009; Perry and Lewis, 2011; Suh and Fulginiti, 2011); and as a curriculum reform tool (Lewis and Tsuchida, 1997; Stigler and Hiebert, 1999; Lewis, 2010; Fan Yang, 2013; Lewis and Takahashi, 2013; Olander and Sandberg, 2013; Takahashi et al., 2013; Tan-Chia et al., 2013).

More specifically, two key research reports discuss key theoretical shifts (Dunphy et al., 2014) and pedagogical approaches (Dooley et al., 2014) that underpin the development of the new Irish primary mathematic curriculum. The potential merit of Lesson Study as a model of PD to support the enactment of the new primary mathematics curriculum is apparent in the research. To successfully enact the new Irish primary mathematics curriculum, Dooley et al. (2014, 13) suggest that teachers will need a profound understanding of mathematics and mathematical knowledge for teaching "that can be developed through collaborative focus on teaching and learning mathematics". In terms of adopting the pedagogical changes necessary to bring the curriculum to life in Irish primary classrooms, Dooley et al. (2014) and Dooley (2019) stress the need for time to be made available to teachers to work collaboratively; and to be afforded opportunities to interrogate and negotiate curriculum change with colleagues as it relates directly to their specific setting or context. For Dooley (2019), Lesson Study provides a valuable space for teachers to engage with the kinds of PD activities that are conducive to curriculum enactment. Furthermore, Dooley et al. (2014, 124) suggest that PD programmes should "focus on children's engagement in mathematics and their responses to mathematical ideas", with Lesson Study spotlighted as rich model of PD for same.

Key differences between traditional professional development and Lesson Study

As evidenced by reviews and evaluations of the curriculum implementation model provided to support the current primary curriculum in Ireland (Sugrue, 2002; Murchan et al., 2005, 2009; Harford, 2010) and the literature presented here on Lesson Study; the following table illustrates and contrasts the key differences between the PD model that attended the 1999 primary school curriculum and Lesson Study,

Table 2. Key differences between traditional professional development and Lesson Study

	In-service model for the 1999 primary school curriculum	**Lesson Study**
Impetus for learning content	Generic agenda for all Irish primary school teachers	Determined by teachers, based on context specific evidence-based needs
Co-ordination of learning	By outside expert or cuidatheoir[3]	By Lesson Study team or small groups of teachers in school
Specialist knowledge of the curriculum	Specialist knowledge is with the cuidatheoir	Specialist knowledge is honed, fostered and maintained in the school
Site of professional learning and development	PD occurs outside of the classroom and sometimes school	PD occurs in the school and classroom setting
Focus of activities	Focus on teacher learning	Focus on student learning
	Professional learning is based on generic and hypothetical learning situations	Professional learning is firmly planted in the realities of classroom life
Problem-solving approach	Support persons bring answers. Learning via a hierarchical structure	Support person brings questions. Enquiry conducted by equals
Efficacy and change	Personal ownership and responsibility	Shared ownership and responsibility

[3] Cuidatheoir is an Irish term used to describe the person who provided support or facilitated PD workshops for teachers to support enactment of the 1999 primary school curriculum.

	Personally accountable	Collective efficacy
Role of Observation	Critique, evaluation, scrutiny of the teachers teaching	Opportunity to investigate student learning cultivated by the group

2.5 Evaluating professional development

The widespread failure of education change initiatives to translate to practice has largely been attributed to a lack of understanding of teacher change and the impact of teacher PD (Fullan, 1991). In addressing this problem, Hargreaves (1996) warns that greater emphasis needs to be placed on ensuring good quality research feeds into evidence-based policy and practice. However, the policy / research relationship is a complex one (Bochel and Duncan, 2007). Calls for studies on curriculum implementation and enactment recommend that researchers systematically collect data on the fidelity of curriculum implementation (Confrey and Stohl, 2004). However, there is little consensus in the literature as to what fidelity of curricular implementation is and how to devise data collection methods to investigate same (Chval, et al., 2008). The question as to what counts as good evidence to inform curriculum reform policy and practice is widely debated. Notwithstanding, the quality of the research or evidence that informs policy is a key consideration for education policy makers and researchers (Hargreaves et al., 2001).

A critical analysis of Irish policy and practice in teacher PD conducted by Sugrue et al. in 2001 revealed a paucity of evaluation and research on PD in the Irish context. This lack of focus on evaluation was also noted in a longitudinal analysis of curriculum implementation in Ireland over the past century (Walsh, 2016). Analysis by Hargreaves et al. (2001, 123) suggests that lack of rigorous evaluation is not unique to Ireland, rather when evaluations are carried out, they are "often limited and poorly disseminated so that models of best practice are not readily available to policy makers or to practitioners". In the UK, impact evaluation has been described as "the weakest link in the professional development chain" (OFSTED, 2006, 19). As a potentially unintended consequence, Sugrue et al. (2001) speculated whether neglecting to conduct research and evaluate PD systematically, as a basis for policy change, conveys subliminal messages to teachers about the importance afforded to evaluation and accountability in the Irish education context more widely.

With the exception of a small body of literature which sits at the juncture between teacher professional learning and curriculum reform policy in Ireland [see Sugrue, 2002; Murchan et al., 2005, 2009; Harford, 2010]; in the main, the literature review has identified a paucity of evaluation research in the Irish context, a claim also made by King (2014). Much of the focus of these sparse evaluative studies is on teacher identity and engagement with PD; and teachers' perceptions of their PD experience. There is little empirical research and evaluation of the quality of PD and its impact and effect on classroom practice (NCCA, 2007).

2.5.1 Problematic nature of professional development evaluation

The purpose of teacher PD is to improve educators and students learning (Mizell, 2010). Timperley (2011) contends that evidence of better outcomes for students is the strongest indication of the effectiveness of professional learning and development; with an increasing number of impact studies alluding to a strong causal link between teacher PD and student learning outcomes (Garet et al., 2001; Yoon et al., 2007; Wayne et al., 2008). However, Cummings (2002) argued that this link is not automatic. More recently, a meta-analysis of 1,300 studies of PD and its impact in terms of student's learning outcomes conducted by Yoon and colleagues (2007) highlighted the lack of evidence and findings to determine the relationship between both[4]. Guskey's (1985, 1986, 2002) seminal work on teacher change through PD further highlighted the narrow view of PD evident in the literature, where PD has typically been conflated with gains in pupil test attainment.

For Donaldson et al. (2009), making determinations of outcomes of PD interventions can be problematic as there is little consensus among evaluators as to what constitutes credible evidence. Guskey (2000) suggests that evaluations of PD tend to typically focus on superficial outcomes such as participants reactions to the PD, which he describes as 'the happiness quotient'. Whereas, Bradley and colleagues (2015) hold that outcomes should be described in terms of practice and desired changes in children's learning. King (2014) suggests that evaluations of PD cannot solely rely on student learning outcomes to explain the success of PD but rather need to also focus on the intricacies and determinants of teacher professional learning, development and change (Opfer and Pedder, 2011). To address this problem and move beyond shallow and ineffective evaluations of PD, Guskey (2000, 2002, 2005) holds that it is necessary to consider multiple sources of evidence. In

[4] Only nine studies met the WWC standards of evidence for inclusion in the analysis.

response, Guskey (2000) proposed a five-level framework of PD evaluation to reflect the various levels of impact or change which can result from teacher engagement with PD. These are

- Level 1. Teachers' reactions (and level of satisfaction with Lesson Study)
- Level 2. Teachers' learning (or acquisition of new knowledge and skills)
- Level 3. Organisational support and change
- Level 4. Teachers' practice (or use of new knowledge and skills)
- Level 5. Children's learning outcomes

These levels represent Guskey's (2000) adaptation of Kirkpatrick's (1998) evaluation framework. The five levels move from simple to complex, and from least to most demanding in terms of evaluating impact. According to Guskey (2002) these levels are interdependent, in that success at later levels is usually contingent on success at earlier levels. Cody and Guskey (1997) hold that while success at individual levels is likely contingent on success at earlier levels, evaluating individual levels in isolation is not sufficient to provide a cogent picture of the programme or intervention. It is suggested that policymakers can fail to recognise the complexities involved in translating professional learning and development to improvements in children's learning (Guskey, 1997; Guskey and Sparks, 2004; Guskey, 2016). As such, evaluating outcomes across multiple levels allows for interim judgements to be made and the generation of evidence that explores how interim changes, or lack thereof, may contribute to or impact children's learning outcomes (Killion, 2017). In doing so, Guskey's (2000) framework contributes to a systems approach to evaluating PD by making explicit the relationships between the many complex factors that interact in the PD process.

2.5.2 Traditional approaches to evaluation

According to Weiss (1966) the basic rationale for evaluation is that it provides information for action and contributes to the rationalisation of decision making. Traditional method-driven or 'black box' approaches, limited to before-after and input-output designs are largely used to evaluate programmes and determine whether an intervention has an impact on outcomes on not (Coryn et al., 2011). However according to Chen (1994), a critical limitation of this traditional approach is that it does not provide sufficient information for improving programmes, nor does it provide the explanatory knowledge necessary to inform the decision-making process. In addition to taking into account the effects of PD at various

levels, Guskey (2000, 9) also emphasized the importance of attending to "the conditions and processes that lead to success, as well as information about unanticipated outcomes".

Guskey (2000) holds that good evaluations have the potential to provide solid and reliable evidence upon which to make thoughtful and responsible decisions about ongoing PD processes and the ultimate effects of those programmes. Notwithstanding, the National Mathematics Advisory Board (2008) suggest that a vast number of the evaluation studies which look at PD in mathematics are descriptive in nature but lack sufficient methodological rigour to determine causal inferences. Relatedly, a review of the literature has highlighted a paucity of research to indicate the mediating factors that exist in the success of Lesson Study and how these factors exert an important influence on what makes for an effective PD experience.

While the Literature Review suggests that Lesson Study is a credible model of PD, it could be argued that past evaluation studies of Lesson Study have focused mainly on the efficacy of the intervention rather than the effectiveness, concerned more with whether it has an impact or not, rather than how and why it has this impact. For example, in 2019, Godfrey and colleagues conducted a meta-analysis of 36 empirical studies which looked at the impact of Lesson Study. This showed that whilst all 36 studies looked at the impact of Lesson Study on Teachers' Learning (Level 2), less than half (17) looked at the transfer of teachers learning to their classroom practice. One third of studies (12) looked at the impact of Lesson Study on student's learning but even then, the majority of these studies relied on teacher reports of improvements to learning. Only three studies were found to gather evidence of impact at all five levels of Guskey's framework (2000).

2.5.3 Evaluations that inform policy and practice

Given the intuitive link between PD and student learning outcomes (Garet et al., 2001; Yoon et al., 2007; Wayne et al., 2008; Timperley, 2011) and the increasing demands of student performance in international assessments (e.g. TIMSS and PISA[5]), it is unsurprising that there is an increasing emphasis on PD both in Ireland and internationally. In Ireland, teacher PD is currently receiving significant attention and investment, as evidenced by policies such as the National Strategy to Improve Literacy and Numeracy among Children and Young People 2011-2020 (DES, 2011) and Cosán, The National Framework for Teachers

[5] Trends in International Mathematics and Science Study (*TIMSS*); Programme for International Student Assessment (*PISA*). See www.erc.ie for more information.

Learning (Teaching Council, 2016). Despite ongoing investment and emphasis on PD as a primary means for improving teachers' professional practice and students learning outcomes, Killion (2017, 26) holds that evaluators "struggle to find practical, meaningful, cost-effective and timely means to evaluate this crucial work". Moreover, notwithstanding the increasing reliance on teacher PD as a core reform strategy (Hargreaves et al., 2001), there remains little systematic information to assess the quality of PD or the contribution of PD to practice and/or student learning outcomes (Haslam, 2010).

Evaluators such as Suchman (1967) and Weiss (1972), recognised that traditional evaluation approaches do not address the causal factors at play in evaluations and rather sought to link the processes between inputs and outputs. Frustrations around the futility and lack of direct use of evaluation results by stakeholders (Weiss, 1972) led to a move to seek out new roles and purposes for evaluation within policy development, implementation and evaluation (Shadish et al., 1991) and an emphasis on tailoring evaluation designs to meet the needs of the programme milieu and measuring improvements in terms of results relative to programme goals (Gascon, 2006). Chen (2015) holds that solely conclusive outcome evaluations have little value in informing policy and practice. Rather, robust contextualised evidence of effectiveness or 'what works' is most appropriate (Davies et al., 2000). This requires a holistic approach to evaluation which "judges a programme not only by its results but also by its context" (Chen, 2015, 21).

Notably, Mushkin (1973) proffers that decision makers tend to be less interested in specific and narrow results provided by most evaluations and more concerned with broader issues and results and how these can be applied beyond the limits of the intervention or programme being evaluated. Killion (2017, 30) contends that fundamentally what policy and decision makers want is "proof that professional learning caused changes to educators' practice and that those practices led to changes in student learning". Riché (2012) suggests that to strengthen evidence of effectiveness, an evaluation study can offer narratives explaining how and why the programme achieved its results. Moreover, these narratives can be strengthened by theories which explain the causal mechanisms underlying intervention variables and offer robustness to the evidence generated (Riggins, 1990). While the specific purpose of evaluations vary depending on the context, Guskey (2000) holds that all good evaluations are deliberate and systematic in so far as they are conducted in a thoughtful, intentional and purposeful way. Similarly, Killion (2017, 26) advises that they must have "clear outcomes, a clear purpose, and appropriate methodology and design".

2.5.4 Addressing scientific and stakeholder credibility

According to Chen (2015), programme or PD evaluations have traditionally tended to concentrate largely on internal validity issues and count only efficacy as evidence. This evidence however is very narrow and not indicative of the viability of PD in the real world. Without evidence of real-world viability, Chen (2015) argues that these evaluations are unscientific. To overcome these issues and be of best use to inform policy and practice, evaluation studies must generate evidence that strike two balances (i) they must generate data that is "robust both in terms of its internal persuasiveness as well as its external applicability" (Davies et al., 2000, 271) and (ii) they must address both scientific and stakeholder credibility (Chen, 2015).

A conflict which exists between scientific and stakeholder credibility, and the value assigned to them by evaluators. Evaluation theorists such as Scriven (1997) argue that evaluations without objectivity have no credibility, whereas Guba and Lincoln (1981) hold that for evaluations to be useful in practice they must respond directly to stakeholder's views and needs. Evaluations that have high scientific credibility typically set the focus and criteria of evaluation around scientific principles but neglect stakeholders views and concerns (Chen, 2015). Problematically, despite scientific credibility, these evaluations are likely to be disregarded by stakeholders because "they fail to reflect their intentions and needs" (Ibid, 22). According to Guskey (2012, 42), "different stakeholders trust different evidence" and the fidelity of different sources of evidence varies among stakeholders. For example, despite the use of standardised test scores as the proxy for successful implementation of policy (Kennedy, 2014), this is often in conflict with what teachers consider to more valid as an indicator of children's learning or evidence of improvement (Guskey, 2006) such as in-class assessments, classroom observations, homework, class participation and behaviour (Guskey, 2012). Chen (2015) contends that as an applied science, evaluations ought to have both scientific and stakeholder credibility.

Importantly, the trust stakeholders place in evidence derived from an evaluation study can influence their interpretations of effectiveness and subsequent decisions taken (Chen, 2015). Powell et al. (2003), cautions against determining effectiveness merely in terms of quantifiable data. Rather, Guskey (2006, 399) holds that "teachers' judgements, insights, and reflections of what constitute significance and value in relation to their own personal, academic, and professional needs and development are equally important". This broader conceptualisation of impact is reflected in Cosán, the new National Framework for Teachers

Learning in Ireland (Teaching Council, 2016) which takes account of the fact that PD can have an impact on many different levels. Importantly, this framework acknowledges the significant role of educational research in signposting for teachers in ways that are most likely to be impactful in terms of their practice. To strike a balance, Chen (2015) suggests that evaluators can address stakeholder credibility in the initial phases of evaluation design, through the collaborative design of an initial programme theory; and scientific credibility later in the evaluation process by assimilating teachers views and assumptions with scientific principles as the research focus, questions and design are developed.

2.5.5 A broader conceptualisation of professional development evaluation

A key criticism levelled at curriculum change policy in Ireland is that it doesn't go far enough to involve those who will be tasked with carrying out the proposed change (NCCA, 2010). Similarly, Stigler and Hiebert (1999) hold that teachers must be the primary driving force behind change that directly affects them as they are best positioned to understand the problems of enacting curriculum change; and to generate possible solutions for same. In order to inform curriculum enactment policies and models, it is suggested that policymakers need to acquire critical insights and evidence of teachers' professional needs and the supports teachers require in responding to these needs (NCCA, 2007). de Paor (2016) goes further to suggest that teachers should be included in the evaluation of their own PD experiences as they are centrally situated to navigate the intervention and evaluate the PD experience in terms of their own context. Given that teachers are the key consumers of PD evaluation outcomes and regarded as curriculum-instruction gatekeepers (Thornton, 1991, 2005), it holds then that in placing teachers and classrooms central to the PD experience means that the site for evaluating quality and impact needs to shift to the classroom, and teachers need to become key evaluators of their own professional learning (NCCA, 2007).

These perspectives align with the wider democratic professionalism agenda, and in particular are congruent with Cosán (Teaching Council, 2016), which places a primary emphasis on teacher autonomy and agency; and professional judgement in transforming professional learning into practice. In accordance with this policy agenda, teachers views and assumptions as to what best reflects evidence of change in their professional learning and practice and their own students learning needs are central to the evaluation model employed in this research study.

Guskey (2012) contends that due consideration needs to be given to how evidence is gathered in PD evaluations and that this process of gathering evidence needs to be explicit and transparent. In particular, the outcome of teachers' professional learning should be known to the teachers from the outset and importantly, they "should have a voice in choosing them" (Ibid, 43). Not only does the involvement of stakeholders in determining what evidence counts provide insights to help teachers take the next steps (Cronbach et al., 1980) and "do better" (Chen, 2015, 21) but it also compounds the message that improvement is a process which requires teacher input and collaboration; and increases teachers' confidence in the fidelity of results (Guskey, 2012). As an additional benefit, Godfrey et al. (2019) suggests that evaluations have the potential to build focus and coherence to teachers' learning when 'built-in' from the start, and thus become more conducive to positive outcomes for children.

2.6 Identifying the research problem

The extant literature suggests that in order to address the gap between policy aspirations and the enacted curriculum in practice; then curriculum reform policy in Ireland necessitates, at its core, a new vision of teacher professionalism and an enhanced model of PD to support curriculum enactment. Lee and Ling (2013) hold that Lesson Study is a PD model through which the intended, enacted and lived curriculum can be more closely aligned. Concomitantly, the need to evaluate the impact of PD and the importance of initial planning to enhance the potential impact of PD (Guskey, 2000; Earley and Porritt, 2010) is strongly implied in recent Irish education policy developments (e.g. DES, 2011; Teaching Council, 2016). Indeed, Irish curriculum policy literature states that "'syllogistic alignment between the evaluation of outcomes or impacts of PD provision and the design of professional development opportunities, must become a key priority for future models of professional development" (NCCA, 2007, 13).

2.6.1 Gaps in the literature

Over the past decade, Lesson Study has been afforded increasing credibility within the literature as a model of PD to successfully support the enactment of curriculum reform (Takahashi, 2014a; Ní Shúilleabháin and Seery, 2017). Across jurisdictions, the employment of Lesson Study in service of curriculum reform has varied across different levels and contexts. General studies have been conducted at national level in Japan (Lewis and

Takahashi, 2013) and China (Fan Yang, 2013); while more subject specific studies have been conducted in the US (mathematics - Takahashi, Lewis and Perry, 2013); Singapore (English language - Tan-Chia et al., 2013); and Sweden (on the concept of Democracy - Olander and Sandberg, 2013).

In Ireland, a small number of studies have been conducted looking at the use of Lesson Study to support teaching and learning in mathematics at pre-service level (Corcoran, 2011b; Leavy and Hourigan, 2016; Ní Shúilleabháin, 2016) and at in-service level in the primary context (Gurhy, 2017) and post-primary context (Brosnan, 2014; Ní Shúilleabháin and Seery, 2017). At post-primary level, there has been a widescale introduction of Lesson Study to support Irish senior cycle mathematics curriculum reform [see www.projectmaths.ie]. Notwithstanding, Lesson Study remains a relatively new approach to PD in Ireland, particularly at primary level. While a number of pilot projects and informal investigations of Lesson Study in the primary context have taken place in recent years, as yet, no empirical study on the effectiveness of Lesson Study to support curriculum enactment has been conducted. Given the impending introduction of the new primary mathematics curriculum at primary level, it may be of value to policy makers and practitioners to learn more about the merit of Lesson Study to support curriculum enactment; so as to inform decision making and planning for implementation, as recommended by Walsh (2016).

A review of the extant literature has highlighted the challenge of curriculum enactment [See section 2.1] and identified a number of issues in addressing the curriculum implementation gap, in particular by exploring how this is influenced by teachers and schools [See sub-sections 2.2.3 and 2.2.4]. Moreover, it has explored teacher professional learning and development and its role in supporting enactment of curriculum in practice, illuminated with insights from evaluations and analysis of historical curriculum implementation in Ireland [See sub-section 2.2.1]. Elements of effective PD to support meaningful engagement in curriculum reforms was discussed, with a particular lens on the enactment of the new primary mathematics curriculum [See sub-section 2.3.5] and the changes and implications for profession development [See sub-section 2.3.2]. Furthermore, the literature was reviewed to highlight the key features of Lesson Study [See sub-section 2.4.1] and investigate the merit of Lesson Study as a model of PD to support curriculum enactment, again specifically in the context of primary mathematics [See sub-section 2.4.2]. Analysis of the literature suggests that Lesson Study holds potential as a model of PD to support Irish teachers to enact the new primary mathematics curriculum, and in doing so

bridge the gap between curriculum policy aspirations, the reality of enacted curriculum in practice and children's learning experiences of mathematics.

That being said, while the overall research picture suggests that Lesson Study is an effective model of PD, often the literature fails to highlight or highlights as an unintended consequence, the mediating factors that exist in the success of the intervention. Moreover, in even fewer instances the literature highlights how these factors exert an important influence on what makes for an effective PD experience. It could be argued that many past evaluation studies of Lesson Study have been focused mainly on the efficacy of the intervention rather than the effectiveness, concerned more with whether it has an impact or not, rather than how and why it has this impact. As such, these studies have fallen short of revealing the specific conditions and factors that must be met to make Lesson Study an effective PD model, information that is important to policy decision making (Coolahan, 2003).

2.6.2 Adopting theory-driven evaluation in this case

Kennedy (2014) contends that there is a need to build upon extant research, to provide theoretical tools for understanding PD in context and more specifically to develop sophisticated but accessible ways of understanding PD in a more meaningful way. Hargreaves et al. (2001, 123) posit that a critical question for research to address in order to inform curriculum reform policy is the effectiveness of PD, in particular its "quality, relevance and impact". It could be argued that knowing whether a relatively new PD model such as Lesson Study works, is relevant only if we also know how and why it works. Therefore, notwithstanding the considerable research efforts in this area, research is needed to remedy the lack of direct attention paid within the literature, to generating specific knowledge about the mechanisms that underlie the effectiveness of Lesson Study, particularly in the context of enacting new primary (mathematics) curriculum in Ireland.

Given the evolution of thinking around evaluation in the context of social science research, there have been a range of changes in what we now accept to be valid evaluation methodologies (Feinstein and Cannon, 2002, De Silva et al., 2014). To fulfil the research goals of this study, traditional evaluation methodologies such as black box or method-driven evaluations were deemed unsuitable. While black box evaluations assess whether an intervention has an impact on outcomes, it is not concerned with the transformational process between the intervention and the outcomes. Similarly, method-driven evaluations

are primarily an “atheoretical activity” (Chen, 2015, 25) where research designs are largely pre-determined by a particular method; quantitative, qualitative or mixed methods. This approach tends to ignore stakeholders’ views and assumptions in the evaluation, which is in stark contrast with the democratic agenda of professionalism espoused in more recent policy developments in Ireland (DES, 2011, 2012; Teaching Council, 2016).

Theory-Driven Evaluation (TDE) offers a solution to traditional evaluation approaches that are limited to before-after and input-output designs and is an increasingly popular method of evaluation among evaluation scholars, theorists, practitioners (Coryn et al., 2011). Early proponents of TDE (Weiss, 1972; Chen and Rossi, 1983; Bickman, 1987; Chen, 1990a) believed that addressing the space between inputs and outputs is critical to understanding and interpreting an evaluation. Opening the black box of evaluation is a unique component of the TDE model that sets it apart from other models. The purpose of TDE is not only to assess whether an intervention works, or not, but also how and why it does so.

Importantly, Van Belle et al. (2010) argues that TDE can be used to good effect in the case of research or evaluation of interventions in complex settings and also in the case of new interventions, for which it is particularly useful to establish an understanding of the causal mechanisms. Indeed, it is widely recognised as particularly effective to evaluate new and complex interventions (Barnes et al., 2003; Davies, 2004; Stame, 2004; Rogers, 2008). Given the complexity of Lesson Study and its novelty as a model of PD in Ireland, TDE was deemed a suitable model to adopt in evaluating Lesson Study as a model of PD to support Irish primary teachers to enact the new primary mathematics curriculum. As an evaluation methodology used in the context of this research study, TDE will be discussed in greater detail in Chapter 3.

2.6.3 Research Questions

In response to the research problems identified in the literature, this research study seeks to open the aforementioned black-box of evaluation to offer plausible explanations for how, why and in what conditions Lesson Study might (or might not) work in Irish primary schools, thus informing policy and practice as to the merit and effectiveness of Lesson Study as a model of professional development to support Irish teachers to enact the new primary mathematics curriculum.

The following three key research questions (in bold) and embedded research questions were selected and framed to attend to these overarching research goals, and in doing so, it

is hoped that they will address a number of gaps identified in the literature review and thus make a contribution to the literature base.

Commented [TC2]: Correction 2

Did Lesson Study work? Or not? To address this question, the research study will seek to determine

- Did it produce the desired and anticipated outcomes described by Irish teachers as necessary to deem it was successful in supporting them to enact the new primary mathematics curriculum?
- In what ways was Lesson Study effective, from the participants' perspectives?
- What impact did Lesson Study have on objective measures of teacher questioning and student learning?

How did Lesson Study work? Or not? To address this question, the research study will seek to determine

- What were participants' evaluation of the model of Lesson Study implemented in the study?
- For whom was Lesson Study successful or unsuccessful?
- From the participants' perspectives, what are the optimal conditions needed for Lesson Study to be effective in supporting curriculum enactment?

Why did Lesson Study work? Or not? To address this question, the research study will seek to determine

- What are the key determinants of Lesson Study that participants attribute to the outcomes found in the study? (across five levels)?
- What contextual factors influenced the outcomes of the intervention?

Given the novelty of the approach adopted in evaluating Lesson Study in this context, the research study will also attend to participants' perspectives on Theory Driven Evaluation by asking

- Was theory-driven evaluation an effective approach to evaluating the teachers' PD (Lesson Study) in this case?
- Was there merit in embedding evaluation into the intervention?

In the next chapter, the methodology adopted to address these research questions will be outlined. This will begin with an overview of the study before discussing key considerations in selecting the methodology and research design employed in the study. The methods and frameworks used to collect and analyse the data collected will also be explained, as will the strategies and steps adopted to ensure the rigour and robustness of the research.

Chapter 3. Methodology

3.1 Aims and rationale

A new primary mathematics curriculum is due for publication in schools in 2021. It is clear from the literature that policy decisions as to the model of PD that ought to attend new curriculum should be based on evidence of its merit to support enactment. Accordingly, this research study aims to inform Irish curriculum policy and practice by investigating and evaluating the effectiveness of Lesson Study to support Irish teachers to enact the new primary mathematics curriculum. In consideration of the novelty of Lesson Study as a model of PD in Irish primary schools; the complexity of teacher professional learning and introducing new curriculum reform; and the policy foundations for education reform in Ireland; the research design for this study adopted a realist approach to evaluation (Pawson and Tilley, 1997), namely theory-driven evaluation (TDE) (Chen, 2015). A theory-driven evaluation approach was chosen in order to address more specific objectives in achieving the overarching aim; to determine 'if' Lesson Study works (and the ways that it is successful or not), 'how' it works (for whom it is successful, or not, and in what conditions) and 'why' it works (the causal mechanisms or determinants at play). Furthermore, based on the findings and refinement of the programme theory central to the evaluation, improvements to the implementation model utilised in the study were identified to enhance the potential impact of Lesson Study in the wider Irish context.

The rationale for adopting a theory-driven approach in the case of this study is manifold. Firstly, theory-driven evaluations are noted in the literature as being particularly useful for evaluating complex interventions (Barnes et al., 2003; Davies, 2004; Stame, 2004; Rogers, 2008) and, in the case of new interventions, for which it is particularly useful to establish an understanding of the causal mechanisms which need to be established for the intervention to be successful (Van Belle et al., 2010). The key research questions identified for this study were (i) did Lesson Study work, or not? (ii) how did Lesson Study work, or not? and, (iii) why did Lesson Study work, or not? [See section 2.6.3 for list of embedded research questions also]. These key research questions were concerned with the transformational process between Lesson Study and, as such, required the evaluation to generate contextualised data rather than simple input-output, cause-effect data. TDE acknowledges that PD takes place in a specific context and that the context generally influences the outcomes, as well as the enactment of the planned intervention. A TDE approach helped to identify the

underlying mechanisms or causal and contextual factors at play and their relationship with and influence on the outcomes. Moreover, proponents of TDE argue that by making explicit the conditions needed for PD and explicating how the outcomes were obtained, the external validity and transferability of findings to other settings is strengthened.

A TDE approach was also selected because of its congruency with current policy agendas of professionalism in Ireland which promote increased teacher autonomy and use of professional judgement; school self-evaluation; and ownership and management of change [See sub-sections 2.2.5 and 2.2.6]. This is illustrated by the recent publication of a number of key Irish education policies such as The Literacy and Numeracy Strategy (DES, 2011), School Self-Evaluation Guidelines (DES, 2012, 2016), Droichead (Teaching Council, 2017) and Cosán (Teaching Council, 2016). Importantly, these policies also situate teacher agency and voice as central to evaluations and developments in education. By generating and testing a programme theory or evaluation model that is primarily based on the views and assumptions of teachers, TDE allows for systematic evidence-based evaluations which hold stakeholder theory; teacher voice, judgement, autonomy and agency; as well as ownership and management of change, central to the evaluation process. In doing so, it concomitantly addresses stakeholder credibility by responding directly to stakeholder's views and needs and thus increasing the trust which teachers place in the evidence generated [See sub-section 2.5.4]. Finally, in practical terms, TDE allowed for a sole researcher to address the research questions comprehensively and in a reasonable timeframe.

3.2 Overview of study

Three Lesson Study teams, each comprised of three primary school teachers, from three Irish primary schools came together in Spring 2018. Over a four-month period (March – June 2018), these nine teachers engaged in three cycles of Lesson Study, facilitated by the researcher. Each Lesson Study team elected and agreed to focus on a Senior Infant class (ages 5-6 years) in their school, as the research class. They were facilitated to focus on two self-identified curriculum themes and areas of the new primary curriculum which they considered challenging to teach and difficult for their children to learn. Through discussion, the three Lesson Study teams selected the Place Value Curriculum Learning Outcome for

Place Value[6] (from the Number strand of the curriculum) as a focus for Lesson Study. They also elected to improve their practice in developing the children's adaptive reasoning skills, a core aim of the new curriculum. Neither Place Value nor adaptive reasoning are explicitly taught to children in senior infant classes in Ireland currently (Irish Primary Mathematics Curriculum, DES, 1999).

Using a theory-driven approach, the researcher worked with these nine teachers to generate a programme theory which made explicit their underlying assumptions as to the outcomes and mechanisms of change necessary for Lesson Study to be successful in supporting them to enact the new primary mathematics curriculum. Over three cycles of Lesson Study, this theory was tested, and evidence gathered to determine teachers' perspectives on the effectiveness of the impact of Lesson Study, the key determinants for change and the test model of Lesson Study implemented.

Evidence generated in the evaluation of the programme theory was further triangulated by summative data collected and also findings from objective measures of the impact of Lesson Study on teachers questioning and children's learning. Additionally, given the novelty of theory-driven evaluation (TDE) in PD evaluation research, the role of TDE as an evaluation approach was also examined and critiqued by participants of the study.

3.2.1 Multi-site case study research design

Evaluations of PD should generate findings that are useful to advocates and purveyors of PD (Mizell, 2010) and policy and decision-makers (Guskey, 2000, 2009). To ensure that this research would achieve this end, particular consideration was given to the research design (Killion, 2017) to ensure that it addressed the central research questions, produced pragmatic outcomes, applied efficacious methods, and produced results that were practical and focused. Moreover, it was also important that the design would be rigorous in terms of internal and external validity and that it would address both scientific and stakeholder credibility.

In practical terms, Guskey and Yoon (2009, 499) advise that any new PD strategy should always begin with small scale studies conducted in the context for which they are intended, to test its effectiveness and "determine if the promised effects in terms of student learning

[6] Curriculum Learning Outcome for Place Value (Stage 1) is "Through appropriately playful learning experiences, children should be able to develop a sense of ten as the foundation for place value and counting" (NCCA, 2017, 34).

gains can be realised" before investing further time, money and other resources. In this study, a multi-site case study research design was employed with the 'case' for investigation being a small sample of Irish primary schools. By examining and illuminating the experiences of teachers and the effectiveness of Lesson Study in three different primary school settings, this multi-site case study aimed to produce data to show within-site patterns and perspectives, and cross-site syntheses (Mills et al., 2010). Using a case-study approach also allowed for multiple methods of data collection (Denscombe, 2003); and importantly, given the research context, allowed for theory building and for teachers to challenge existing theoretical beliefs about their professional learning and development (Robson, 2002; Denscombe, 2003).

Commented [TC3]: Correction 3

Upon applying a multi-site case study design in two schools, Mulford and Silins (2003) concluded that this approach was very useful in addressing 'how' and 'why' questions. By illuminating the experiences of teachers across three research sites (schools) it was intended that wider understandings and evaluations of Lesson Study would emerge (Mills et al., 2010). Eliciting comparative and contrasting findings across sites is a strength of multi-site case study design (Mills et al., 2010). An identical data collection and analysis approach was employed across each of the research sites which enabled cross-site syntheses, replication claims and generalisable insights (Mills et al., 2010). Whilst attending to the possibility of researcher bias and the potential impact this could have on the outcomes of the study (Robson, 2002), this consistent approach across research sites gives greater confidence in attributing the outcomes to the intervention (Guskey, 2017) and greater confidence to the research field than a single case study (Herriott and Firestone, 1983).

Denscombe (2003) reports that case study findings can be perceived as soft and as offering little value to explain change, particularly given the challenges to understanding the cause-effect relationship. Notwithstanding, in using a TDE approach to evaluate Lesson Study in this study, the rigour of the research design was strengthened through a combination of both conceptual and empirical tasks (Rogers et al., 2000). The programme theory provided both a conceptual framework for planning and monitoring the Lesson Study intervention; and an empirical framework for evaluating Lesson Study to determine what intended (and unintended) outcomes were achieved, and how Lesson Study contributed to the outcomes. Moreover, the implementation model of Lesson Study was tested to determine if conditions put in place to implement Lesson Study were successful; and in what ways these conditions could have contributed to or impeded the success of Lesson Study in supporting

teachers to enact the new primary curriculum. By identifying the conditions that make it more probable for Lesson Study to be successful and how the effects were obtained, it is argued that the external validity and transferability of findings to other settings is strengthened (Donaldson, 2013; Chen, 2015).

3.2.2 Research sample - Profile of schools and participants

With this multi-site case study, it is important to consider the profile of the teachers who participated in the study. After approaching five schools to participate in the study, three schools elected to participate. Schools were initially approached based on school size and thereafter with consideration of location and proximity. Given that the majority of international studies conducted on the use of Lesson Study in the context of curriculum reform have taken place in large schools, with multiple teachers teaching the same class level (Taylor et al., 2005) , school size (number of teachers and children) was of primary concern when recruiting schools to participate in this study. This particular variable (school size) was essential to evaluating a novel PD model like Lesson Study in the context of Irish primary schools, as the demographic of primary schools in Ireland is relatively unique.

In Ireland, owing largely to the small population (4.76 million)[7] and relatively large number of primary schools (3,241)[8], 55.9% Irish primary schools have multi-grade classes (CSO, 2019). In fact, just over a quarter (26.1% - CSO, 2019) of Irish primary schools have four teachers or less, where teachers typically teach at least two grade levels concurrently. In contrast, despite having a slightly larger population, the school structure in Singapore, where Lesson Study has a long tradition, is very different. In contrast to Ireland's 3,241 schools, there are only 185 primary schools in Singapore [see 2019 statistics, www.moe.gov.sg]. Correspondingly, the challenge of PD provision to support the enactment of curriculum in Ireland is also relatively unique.

For the purposes of this study, schools were categorised as small where the school had an enrolment of less than 100 children; medium where the school had an enrolment of between 100 and 250 students; and large where the school had over 250 children enrolled. Each Lesson Study team was comprised of three teachers. Among this sample of nine participants, there were teachers of varying ages, backgrounds and experience. Within this

[7] According to the most recent census in 2016 conducted by the Central Statistics Office, Ireland (www.cso.ie)
[8] As per the 2019 statistics, calculated by the Central Statistics Office, Ireland (www.cso.ie) (www.cso.ie)

cohort, one teacher was newly qualified, three teachers had 5-10 years of experience, two teachers had between 10- and 20-years' experience, while the remaining three teachers had over twenty years teaching experience. There was a relatively similar spread of experience in each of the three schools. From the outset, all participating teachers expressed that they enjoyed, and were interested in, teaching mathematics, however there were differing levels of confidence in teaching mathematics.

Coded pseudonyms are used to provide anonymity for the participants involved. In the small school, teachers are referred to as names beginning with 'S'. Similarly, teachers are referred to as names beginning with 'M' in the medium sized school, and 'L' in the large school. For ease of reference, the second letter in teachers' names are 'a', 'e', and 'o' respectively. The following table provides an overview of the demographic for each school. For each school, the teachers' age range, teaching experience range, the position they currently hold in the school and some brief background information on their interest and confidence in teaching mathematics is outlined.

Table 3. Profile of schools and participants

	Pseudonyms	Age range	Years Exp	Position	Self-reported background information on mathematics teaching
Small School	*Demographic:*	*Small rural mixed-gender primary school with four class teachers including a teaching principal; and approx. 95 children.*			
	Sandra	50+	30+	SET[9]	Enjoys, interested in, and confident in teaching maths.
	Selena	30-39	10-15	Class Teacher	Enjoys and interested in teaching maths but finds it difficult to teach.
	Sonya	40-49	15-20	Class Teacher	Enjoys and interested in teaching maths but finds it difficult to teach.
Medium School	*Demographic:*	*Medium-sized, mixed gender suburban primary school with 8 class teachers, an administrative principal and approx. 200 children.*			
	Maria	50+	30+	Class Teacher	Enjoys, interested in and confident in teaching maths.
	Megan	30-30	5-10	SET	Enjoys and interested in maths. Some confidence issues with teaching maths.
	Molly	20-29	5-10	Class Teacher	Enjoys and interested in maths. Some confidence issues with teaching maths.
Large School	*Demographic:*	*Large urban primary school for girls with 13 class teachers, an administrative principal and approx. 350 children.*			
	Lauren	20-29	5-10	Class Teacher	Enjoys, interested in and confident in teaching maths.
	Leah	30-39	0-5	Class Teacher	Enjoys, interested in and confident in teaching maths. Finds some concepts difficult to teach.
	Lorraine	40-49	25-30	Class Teacher	Enjoys, interested in and confident in teaching maths.

[9] In Ireland, SETs or Special Education Teachers are deployed in mainstreams schools to address the needs of children with special educational needs (DES, 2017b)

3.2.3 Timing of evaluation

A critical pitfall identified in centralised strategising for curriculum change is the timing of evaluations. Weiss (1972, 318) stated that "unless evaluations gain serious hearing when programme decision are made, it fails in its major purpose". In Ireland, the education sector is typically slow to collect comprehensive data in advance of the introduction of change (NCCA, 2007). Walsh (2016, 12) found that in the past, even when research was undertaken that signalled the need for a new direction or modification of policy "little timely and concerted action was undertaken to improve curriculum implementation in practice". The literature suggests that neglecting to conduct evaluative studies in a timely manner (i.e. before widespread reform is mandated), may result in PD efforts failing to respond appropriately to the needs of teachers and, in turn, result in limited change in practice.

The new Irish primary mathematics curriculum is due for publication in 2021. Following its publication, Irish primary school teachers will engage with PD to support the enactment of this curriculum. Considering the lessons that research has taught us about the shortcomings of previous Irish education policy efforts to support curriculum implementation [See sub-section 2.2.1], the timing of this evaluation study is important if it is to offer empirical insights which may contribute to, and inform, policy deliberations as to what supports are necessary to support enactment of the new curriculum.

3.3 Selection of methodological approach

3.3.1 Methodological considerations

In simple terms, evaluation is the systematic investigation of merit or worth (Joint Committee on Standards for Educational Evaluation, 1994). There are typically two types of evaluation which can be undertaken: efficacy evaluation and effectiveness evaluation (Kellam and Langevin, 2003; Flay et al., 2005). At a theoretical level, the type of evaluation deemed to have the greater value in serving evaluation has been debated in the literature (Donaldson et al., 2015). Efficacy or experimentation evaluations typically involve Randomised Control Trials (RCTs) or the use of tight research controls to achieve the highest possible internal validity, and thus can provide highly convincing and precise evidence of the effect of an evaluation (Flay, 1986). Advocates of this approach are typically influenced by Campbell and Stanley's (1963) views which hold that internal validity is the most critical issue for research to attend to. However, notwithstanding the importance that

these studies have in contributing to the research base on PD, Wayne et al. (2008) hold that this approach alone presents issues around generalisability.

Critics of RCTs and Campbell and Stanley's views of internal validity hold the position that this approach to evaluation often constrains evaluators given its difficulty to conduct and administer in real world settings (Porzsolt et al., 2015). Similarly, Chen (2015) cautioned that many of the evidence-based interventions produced in ideal or controlled settings produce evidence which lacks the potential to address real problems in real-world settings. Moreover, Greene (2009) holds that this approach may overlook contextual factors and the influence that context has on an intervention. In contrast, effectiveness evaluations assess the effectiveness of an intervention in real-world conditions (Kellam and Langevin, 2003; Flay et al., 2005) and in doing so, embrace a phenomenological stance and promote naturalistic approaches to understand the human experience in natural settings (Guba and Lincoln, 1989). In the absence of a controlled setting, evaluators do not have direct control over the implementation process or research milieu, leading to the sites of evaluation being described as "messy" (Chen, 2005, 205).

The move to encourage more emphasis on external validity in evaluations is growing in the literature (Chen, 2005; Green and Glasgow, 2006; Wandersman et al., 2008). Cronbach claimed that internal validity is "trivial, past-tense, and local" (Cronbach, 1982, 137) and over-reliance on internal validity means research is often too narrow to serve evaluation and thus futile to policymaking (Cook, 2002). Given the parameters of the study and the controlled conditions under which efficacy studies are typically conducted, it was not possible to conduct an experimental or quasi-experimental research design. In any case, notwithstanding the strengths of efficacy studies, a scientifically rigorous or internally valid determination of the efficacy of a study also does not guarantee that an intervention such as Lesson Study is, or is likely to be, applicable in the real world (Wandersman, 2003; Chinman et al., 2005; Green and Glasgow, 2006; Wandersman et al., 2008). As an alternative, Davies et al. (2000, 271) advised that internal validity can be ensured and confidence in external reliability increased by providing a "contextualised understanding of effectiveness".

Given the imperative for the research to be useful to policy and decision makers, it was critical to this study that an approach was used that that would ensure both internal and external validity (Chen and Rossi, 1987). The TDE approach was largely developed as a reaction to the positions of Cronbach (1982) who held that evaluation is futile to policy

making if its external validity is not assured; and Campbell and Stanley (1963) stated that internal validity is the issue of most critical importance in research. While traditional case studies and evaluations typically hold low external validity and little value to explain change (Costner, 1989), Chen and Rossi (1989) propose that a TDE approach to evaluation ensures both types of validity. TDE makes potential threats to internal validity explicit and controllable and in doing so avoids potential pitfalls and strengthens the internal validity of the evaluation. At the same time, by indicating the conditions needed for Lesson Study to be successful and how the effects were obtained, external validity and transferability of findings to other settings is strengthened (Chen, 2015). Importantly, TDE also provides a contextualised understanding of effectiveness by opening the black box of evaluation, to provide a better explanation of the varying causal mechanisms and relationships underpinning Lesson Study as a model of PD to support curriculum enactment.

3.3.2 Theory-driven approach to evaluation

Given the research context and aims, it was crucial that an appropriate evaluation approach was utilised to meet the particular objectives set out (Desimone, 2009). TDE addresses the 'black box', or what can be seen as the space between PD and outcomes, which is often ignored in evaluations (Stame, 2004) that seek to determine not only whether an intervention *works* or *does not work,* but also *how* and *why* it does so. Salter and Kothari (2014) suggest that this is a unique component to TDE that sets it apart from other evaluation approaches and models, and in doing so, offers a solution to traditional or method-orientated evaluations which tend to focus solely on input-output issues (Chen, 1989; Chen and Rossi, 1989).

Over the past thirty years, theory-driven evaluation (TDE) has gained increasing prominence in the evaluation field (Weiss, 1972, 1997, 2007; Chen and Rossi, 1983, 1992; Bickman, 1987; Chen, 1990a, 2005; Pawson and Tilley, 1997; Donaldson, 2007; Coryn et al., 2011). In the literature, it is also referred to as theory-based evaluation, theory-guided evaluation, theory-of-action, theory-of-change, program logic and realist evaluation (Pawson and Tilley, 1997). More recently it has appeared in the literature as program theory-driven evaluation science (Donaldson, 2007) or integrated evaluation (Chen, 2015); among a range of others (Rogers, 2000a, 2008; Rogers et al., 2000; Stame, 2004).

For the purpose of this study, TDE is defined as an evaluation approach which explicitly integrates and uses stakeholder and social science theories in conceptualizing, designing,

guiding, and applying an evaluation model (Coryn et al., 2011). A TDE approach was adopted in this study because it was a methodological approach that was sensitive to the complexity of the intervention in question (Lesson Study) and the context of delivery (Davies et al., 2000, 271). A programme theory was developed based on Irish primary school teachers' descriptive and prescriptive assumptions as to how Lesson Study ought to work, what outcomes it would need to produce to be deemed successful in supporting them to enact the new primary mathematics curriculum, and what determinants might cause or lead to these outcomes. This programme theory then became the framework with which to evaluate the model of Lesson Study employed in the study (Birckmayer and Weiss, 2000). The programme theory develop in this study will be explained in greater detail in section 3.4.

When applied to this evaluation framework, social science research theories were useful to help explain anomalies and patterns of findings. Riggins (1990) holds that social science theories can help to strengthen the validity of claims of causal relationships by reinforcing and explaining the relationships between variables at play in the intervention. Conversely, where stakeholders disagreed in their assumptions as to how the intervention worked or impacted different outcomes, social science theories were useful to explore different hypotheses or chains of reasoning (Donaldson and Lipsey, 2006).

For clarity purposes, this research was not concerned with evaluating the programme theory. In this study, the purpose of the programme theory was to describe, from Irish teachers' perspectives, how a particular model of Lesson Study ought to work to support curriculum enactment. In doing so, the programme theory makes this test model and process of change explicit. To determine the merit of Lesson Study as a model of PD to support enactment of the new primary mathematics curriculum, the evaluation focused on the relationship between Lesson Study outcomes, determinants and the test model of Lesson Study implemented in the study.

Strengths of theory-driven evaluation

A unique strength of TDE is that evaluation stakeholders' implicit prescriptive and descriptive assumptions underlying interventions are made explicit and elaborated (Chen, 1990a, 2005) and causal links and relationships between intervention and outcomes are revealed (Van Belle, 2010; Chen, 2012). This allows for determinations about not only the effectiveness of interventions, but also how and why they work (Chen, 1990a, 2005;

Pawson and Tilley, 1997; Donaldson, 2003, 2007; Rogers, 2000a). While attributing change to an intervention is challenging, Pawson and Tilley (1997) argue convincingly, that in such cases, theory-driven evaluations offer plausible explanations, not probabilistic statements of attribution. In generating such knowledge claims, they thus hold strong potential to inform policy and practice (Trochim, 2009) and consequently social betterment (Donaldson and Lipsey, 2006; Donaldson, 2007). Furthermore, where an intervention is found to be ineffective, a TDE approach can uncover where breakdowns occurred and attribute this failure to unintended or unanticipated outcomes and consequences of the intervention (Coryn et al., 2011); or perhaps to implementation failure or programme theory failure (Chen, 2012).

TDE facilitates enhanced stakeholder engagement in the design and development of interventions and embeds evaluations in the local context (De Silva et al., 2014). In doing so, Chen (2012) holds that it increases the capacity of teachers and schools to implement and evaluate interventions for themselves in the future. On a practical level it also enhances evaluators "sensitivity to planning, goal clarification, implementation, stakeholders' needs and social change theories in general" (Chen, 1990a, 29). Furthermore, from a policy perspective, it meets the challenge of determining what works, how and why, to improve policy decisions and practice (Pawson and Tilley, 1997; Stame, 2004) and in doing so is considered to help the consumers of policy to have a better understanding of the political processes underpinning interventions (Stame, 2004). Rogers (2000, 209) asserts that "at their best, theory-driven evaluations can be analytically and empirically powerful and lead to better evaluation questions, better evaluation answers, and better programs''.

Critique of theory-driven evaluation

Notwithstanding the strengths of TDE proposed by its proponents, TDE has also been subject to critique in the literature. Coryn (2005; 2007; 2008) has criticised the transparency of TDE given that research studies can be elusive in terms of whether it is the intervention or the programme theory which is being evaluated, and that potential for confusion arises where evaluation models are presented as fixed representations of evaluation theories (Coryn et al., 2011). Stufflebeam and Shinkfield (2007) also indirectly highlighted the potential for conflicts of interest where evaluators are evaluating programme theories that they themselves developed or at least played a major role in

developing, positing that “failed or misrepresented attempts can be highly counterproductive’’ (Ibid, 187).

Coryn et al., (2011) cautions that particular attention needs to be given to identifying unanticipated consequences and outcomes not hypothesized or postulated in the programme theory. This is why stakeholder engagement throughout the evaluation process is critical to ensure the internal validity of theory-driven evaluations and why plausibility checks were conducted before and during the evaluation process (Donaldson, 2007). These measures can help to negate and limit the potential for implementation and programme theory failure and ensure that the evaluation model is not too fixed to take into consideration unanticipated consequences and outcomes. A further criticism levelled at TDE literature, is that while it is useful in describing what an evaluation needs to do, it is less descriptive in terms of how to do it (Coryn, 2009), particularly when principles and procedures are abstract (Coryn, 2007), which may account for why TDE approaches are considered ambiguous and not more widely used in evaluation studies.

Despite the assertions made by TDE proponents and critics alike, Coryn et al. (2011) concede that little, if any, evidence exists to justify or falsify them. On the contrary, following an analysis and synthesis of past case study evaluations, Donaldson (2003) posits that TDE can work very effectively when the chances of design sensitivity and validity errors are minimized; when stakeholders are empowered to use the findings to continuously improve their practice and efforts; and when the evaluation generates knowledge that contributes to and improves programmes and interventions.

3.3.3 Programme theory as framework for evaluation

The ability to specify the theory underpinning programmes is essential for programme evaluation (Stevahn et al., 2005). The core tenet of theory-driven evaluation (TDE) is that the design and application of evaluation needs to be guided by a framework called programme theory (Chen 1990, 2005; Torvatn, 1999). Whilst not exclusive to TDE, this tenet is based on the premise that “to adequately assess the merit of a programme, both its intrinsic value and the context in which that value is assigned must be considered together” (Chen, 2015, 5). A programme theory explains how an intervention (such as Lesson Study) is understood to contribute to a chain of results that cause intended or actual outcomes (Rogers, 2000b). Because stakeholders’ views and assumptions are typically implicit and therefore “not likely to be systematically and explicitly articulated” (Chen,

2015, 367), programme theory makes their views and assumptions explicit, and in doing so, allows the researcher to assess the effectiveness of the programme more comprehensively.

Programme theory builds on the work of social scientists Weber (1947) and Durkheim (1895) whose work provided explanations of organisational and societal phenomenon but also steps for improving same. Programme theory goes beyond typical social science theories that focus solely on providing causal explanation of interventions and on developing "generalisable propositions, statements and laws" (Chen, 2015, 69). Rather, programme theory is equally concerned with "the nuts and bolts issues" of how a programme or intervention works (Ibid, 69). In this way, it captures the often implicit set of assumptions held by the researcher and participants as to how an intervention 'ought' to work to support the enactment of the new primary mathematics curriculum, what outcomes demarcate the success of an intervention, and what contextual or causal factors contribute to solving the problem (Chen and Rossi, 1992).

There are different versions of programme theory. One comprehensive version of programme theory that has wide application in practice is Chen's (1990a) action model/change model schema [See figure 3 below] which he describes simply as "a systematic configuration of stakeholders' prescriptive and descriptive assumptions underlying programmes" (Chen, 2015, 66). With many interventions, these assumptions are not made explicit, rather it is presumed that all stakeholders share the same assumptions (Chen, 2015). Making these assumptions explicit not only allows all participants to understand what intervention is being implemented and why, but also importantly, this schema can be used as a framework to guide the choice and design of the evaluation, the selection of research methods, and the collection and analysis of data (Ibid).

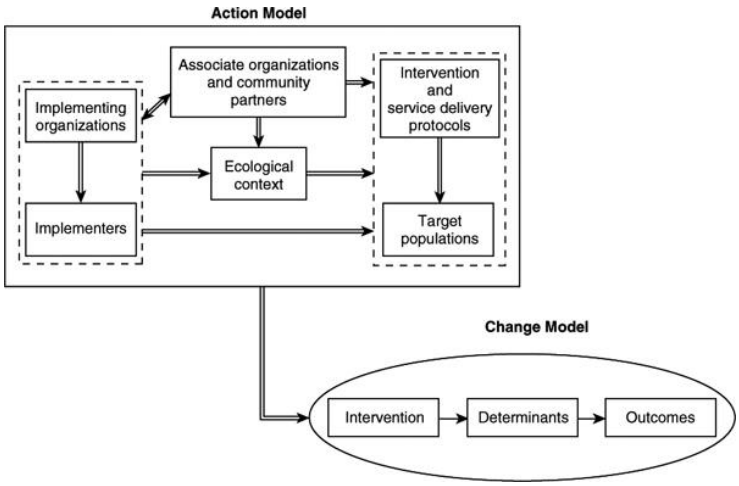


Figure 3. Action model/change model schema (Chen, 2005, 2015)

Individual elements of action model / change model schema

Sometimes referred to in the literature as normative or prescriptive theory, an *action model* is a systematic outline of the conditions, resources, staff, settings, and support necessary for the programme or intervention to be successfully implemented (Chen 1990, 2015). The action model of Theory of Action (ToA) outlines stakeholder's prescriptive assumptions as to the components, activities and conditions that are necessary for the intervention to be successful (Chen, 2015). Specifically, it comprises a description of the context for the intervention, the supports that participants detailed as necessary for the intervention to work, and the partnerships and collaborations that were involved in the intervention. It also outlines the key conditions, resources and protocols deemed necessary by participants for the intervention to be of appropriate quality.

Evaluation of the ToA determines how the planned intervention was implemented and allows to check whether an unsuccessful intervention may be attributed to implementation failure or programme design failure (Van Belle et al., 2010). The action model describes stakeholders' prescriptive assumptions (Chen, 1989; Stame, 2004) of the following elements:

- Capacity of team to implement the intervention
- Competence of the intervention leader to guide teachers
- Capacity of team to work collaboratively
- Protocol that specifies content and activities, and steps to be taken

- Micro-level contextual support (materials, access to research, etc.)
- Macro-level contextual support (school culture)
- Willingness and commitment of participants

Sometimes referred to as causative or descriptive theory, a *change model* or Theory of Change (ToC) depicts the teachers' descriptive assumptions of what causal events or processes are expected to lead to the desired outcomes. Evaluation of the ToC investigates if the expected outcomes (anticipated as necessary for the success of the intervention) were achieved in actuality, and also determines the causal processes and the intervening contextual variables that produced these outcomes. The change model describes stakeholders' descriptive assumptions (Argyris and Schon, 1978; Chen, 1989) of the following:

- Goals and measurable outcomes
- Determinant or intervening variables that can act as a leverage to meet goals
- An intervention directly aimed at changing a determinant

3.4 Programme theory development

Involving stakeholders in theory development is the ideal situation (Wight et al., 2016). Accordingly, in this study, the nine participating Irish primary teachers (key stakeholders and consumers of the evaluation - Thornton, 1991, 2005), were facilitated by the researcher to elaborate on Chen's (2015) action model /change model schema [See Figure 3 above] to develop an Initial Theory of Action (ToA) and an Initial Theory of Change (ToC). Together, the initial ToA and ToC comprised the programme theory which served as a plausible and theoretically responsive framework for evaluating Lesson Study (Chen, 1990b; Sedani and Sechrest, 1999; Rogers, 2000a; Stufflebeam, 2000). Put simply, this framework described, from the teachers' perspectives, how Lesson Study ought to work in order to deem that it had been successful in supporting them to enact the new primary mathematics curriculum. The evaluation of Lesson Study was guided to measure constructs postulated in the programme theory (Chen, 2015) that spoke directly to the three key research questions and, in doing so, reduced the potential for reaching conclusions that were misleading or irrelevant to the overall research goals and aims.

Guskey (2000, 87) asserts that:

> "while it is near impossible to prove that a professional development intervention caused improvement in children's learning, it is possible to collect evidence to suggest that the professional development contributed to the improvement".

The research design applied in this study aimed to provide evidence upon which to make determinations as to whether, and in what ways Lesson Study supported teachers to enact the new primary mathematics curriculum (Guskey, 2000) across the five levels of evaluation; and why.

3.4.1 Logic model of programme theory

Given the multi-site case study design, a critical component of this study was to enunciate and establish a shared understanding of the programme theory among all participating teachers; to make explicit their assumptions as to how the intervention relates to the outcomes as well as their assumptions as to the underlying mechanisms at play. Because interventions are usually complex, it is essential that the way various aspects are considered to relate to one another is well developed and articulated (Davidson, 2005). In this case, a logic model was devised to illustrate the relationship and alignment between the conditions, actions, resources, outputs, and outcomes of the intervention PD (Killion, 2008) and in doing so, also convey the complexity of the evaluation which took place in the study.

As with the process of developing the programme theory, evaluation proponents advise that logic models should be developed inclusively and collaboratively with key stakeholders (Kneale et al., 2015). Developing a logic model of the programme theory with participants from the outset of the intervention had a number of advantages to offer the planning and evaluation process. Involving participating teachers in drafting the logic model helped to develop shared understanding and strengthen "consensus and group examination of values and beliefs about change processes and program results" (Ibid, 6). In doing so, it avoided teachers reverting to individual interpretations of the framework which might have conflicted with or complicated their understanding of the change process, and consequently, research findings and outputs.

In this study, a logic model served to strengthen the theoretical soundness of the programme theory established by the evaluation participants and provided a useful conceptual tool for the participants and researcher. In devising the logic model or 'big picture' or representation of the programme theory, the researcher worked with the

participating teachers and consulted the social science across the following sequential steps.

Step 1. Identifying outcomes and indicators of success across Guskey's (2000) five critical levels of PD evaluation.
Step 2. Identifying causal factors or determinants of Lesson Study
Step 3. Describing the Theory of Action (ToA) which elucidates the model of Lesson Study employed in the study.

This diagrammatic representation of the initial programme theory [See figure 4 below] exposed and catalogued the implicit assumptions underpinning Lesson Study by explicating the anticipated impact of the intervention goals in terms of specific, measurable, action-orientated, realistic and plausible outcomes; and demarcating the relationship between the intervention, intervening variables and outcomes. Put simply, it delineates the overall logic of how and why Lesson Study was understood and anticipated to work initially to support curriculum enactment.

Initial Theory of Action

Test model for implementing Lesson Study in case study schools

Context for Lesson Study

What: Model of professional development where teachers collaboratively plan, teach, observe and reflect on teaching and learning practices; explore and share new teaching approaches, strategies and ideas, and gain insight into student learning.
Where: In-school meetings
For who: Primary Teachers (all ages and levels of experience)
When: 3 cycles over 4 months (March – June 2018)
Why: To support teachers to enact the new curriculum, internalise and promote the aims of the curriculum, facilitate rich learning experiences for children as promoted in the curriculum

Ecological Supports

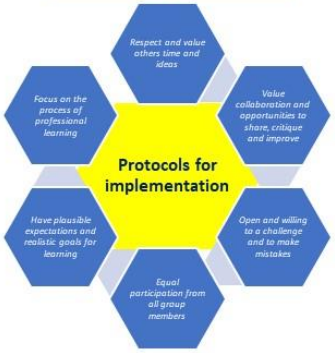
Micro
Lesson Study team

- Encouragement, support, reassurance and respect from colleagues
- Protocols or norms for individual schools

Macro
School Level

- Support from school leadership
- Time to meet, plan, teach and observe lessons
- Sub cover and management of classes
- Provision of resources, materials, space/room

Lesson Study cycle



Implementation Quality

Facilitation	Curriculum materials	Lesson Study materials
Expertise on topic under investigation **Experienced facilitator** **Facilitator attributes** • Commitment • Enthusiasm Communication Constructive feedback • ICT literate • Interpersonal skills • Managing reluctance	**Curriculum specification** **Teacher Toolkit** • Key concepts • Misconceptions • Key vocabulary • Open-ended tasks • Sample lesson plans • Formative assessment tools • Questioning • Support for parents • Songs, games, activities	**Lesson Study Handbook** **Lesson Plans and Observation / evaluation templates**

Partnerships and Collaborations

- Working with Knowledgeable Other – Dr. Noreen O Loughlin (Mary Immaculate College)
- Working with case study schools on agreeing shared programme theory and evaluation framework
- Work with teachers with varying experience and expertise in primary mathematics
- Communication group (whatsapp)
- Sharing of curriculum study materials and resources

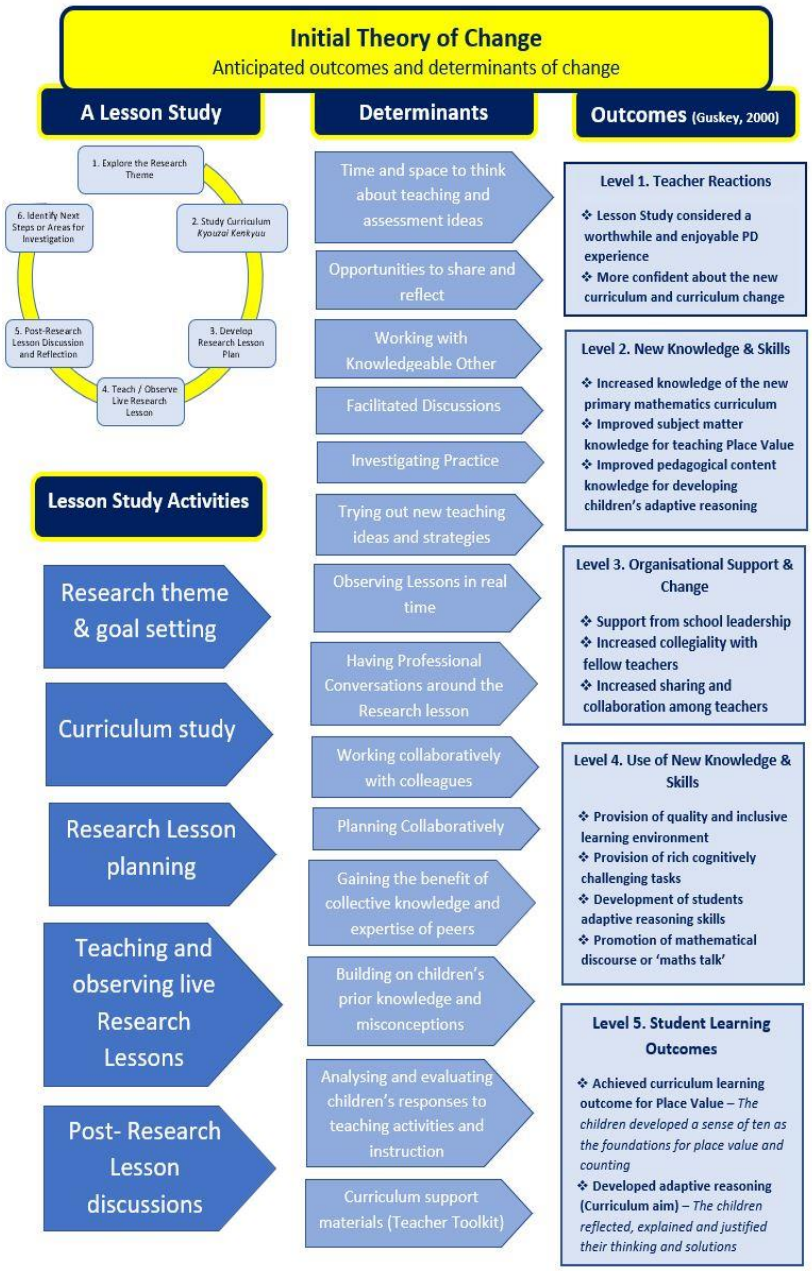


Figure 4. Logic model of programme theory under investigation

3.4.2 Stages of programme theory development

Programme theory development is an iterative process (Kneale et al., 2015). Broadly following Donaldson's (2007) guidelines, this framework for evaluating Lesson Study was developed over four stages.

Preparation stage (researcher only)

At this stage, the researcher conducted a literature search and devised a preliminary working draft of the programme theory. Steps taken during this stage included:

- Reviewing the literature and findings from evaluations of Lesson Study and processes/activities cited as contributing to achievement of outcomes.
- Exploring the contextual and causal factors cited in the literature that contribute to success of Lesson Study and curriculum enactment or actualisation.
- Devising an initial sketch outline of the programme theory and logic model based on literature search.

Pre-intervention stage (all participants and researcher together)

At this stage, all Lesson Study team members assembled together at an induction meeting and were encouraged to collaboratively draft the initial programme theory by expressing their own prescriptive assumptions about the contextual or action factors (what needs to be done or put in place) and their descriptive assumptions about the causal or change factors (what needs to happen); in order for Lesson Study to support them to enact the new primary mathematics curriculum. Steps taken during this stage included:

- Presenting sketch working drafts of logic model to participants for discussion, reaction, input and refinement. Exploring assumptions of all actors through group discussion. Describing and assessing rival programme theories. Editing the logic model.
- Probing the process and critical links between intervention, intervening variables and outcomes [See next section – Guiding programme theory development]. Ensuring that the teachers and researcher had an accurate understanding of the programme as it is collectively understood to proceed.
- Establishing consensus and shared understanding among all teachers.
- Ascertaining participants' understanding of Lesson Study and conducting a plausibility check to ensure the initial programme theory and logic model draft are representative, fair and accurate and outcomes are attainable.
- Agreeing and generating initial draft of programme theory. Assessing the plausibility of initial programme theory in consideration of relevant contingencies (e.g. usability, time, budget constraints, availability of resources and supports).

- Making any necessary revisions and finalising initial draft of programme theory upon consensus and agreement of teachers.

Teachers were also consulted on how best to evaluate the programme in terms of self-reporting, observations and collection of document evidence [See next section - Guiding programme theory development].

Intervention stage (researcher and Lesson Study teams)

As a further plausibility check, the researcher revisited existing research and evaluations relevant to the updated initial programme theory to assess the plausibility of questionable links (e.g. did the research suggest that the link could occur as planned? Could the programme action lead to the intended outcomes?). Before the intervention started in individual schools, the initial programme theory was reviewed by each Lesson Study team, any additions or edits were made and agreed upon and finalised. During the Lesson Study intervention itself, the data used to test different aspects of the programme theory was explained as well as the analytic techniques used with particular data sets.

Analysis Stage (researcher only)

Following the completion of the three cycles of Lesson Study, the findings of the ToA and ToC evaluation were formulated, analysed and discussed with participants [See sub-sections 3.5.3, 3.5.4 and 3.5.5]. To assist the participants to understand how and why the pattern of Lesson Study outcomes existed; evidence of outcomes and, context and causal mechanisms were explicitly aligned against the programme theory to provide a transparent basis for judgements about the merit of Lesson Study. The participants also explored competing theories as well as unanticipated outcomes and determinants of change. The output of this analysis and discussion was to refine the programme theory so that it could be integrated into the existing body of theory and knowledge about Lesson Study.

Guiding programme theory development

The following table outlines a sequence and series of 'If/then' questions used by the researcher to guide participating teachers in developing the initial programme theory. It also includes ''*If/then*' questions posed to support the generation of meaningful and

scientifically rigorous evidence. The answers to these questions are reflected in the initial programme theory [See sub-section 3.4.1].

Table 4. 'if/then' guiding questions for developing and monitoring the programme theory

	Steps	***'If/Then'* Guiding Questions**
Theory of Change	1. Identifying outcomes	*If* engaging in three cycles of Lesson Study had been successful in supporting you to enact the new primary mathematics curriculum, *then* what outcomes would need to have been achieved at Level 1/2/3/4/5? (Guskey, 2000)
	2. Identifying success indicators	*If* Lesson Study had been successful to achieving outcomes at Level 1/2/3/4/5 (Guskey, 2000), *then* what indicators of success would need to be evident?
	3. Identifying determinants	*If* your engagement with Lesson Study was successful in supporting the enactment of the new primary mathematics curriculum, *then* what causal factors or determinants of Lesson Study could this be attributed to?
Theory of Action	4. Identifying contextual factors and conditions of Lesson Study	*If* ecological supports are needed to enhance the effectiveness of Lesson Study, *then* what supports would be required from the Lesson Study team? From the wider school community? *If* partnerships or collaborations are required, *then* what would be most effective? *If* the quality of the intervention was appropriate, *then* what would be essential components or tools of facilitation, curriculum materials and Lesson Study materials provided over the course of the intervention? *If* Lesson Study teams were to work well in achieving the desired goal, *then* what kinds of protocols would be necessary?
5. Generating evidence		*If* Lesson Study had produced the outcome expected, *then* what evidence could be provided to establish this? *If* the indicators of success were evidence, *then* how could they be measured? *If* the Lesson Study determinants could be attributed to the outcomes, *then* how could this be determined?

Developing the initial programme theory

A core strength of the ToC is that it opens the 'black box' of evaluation by making explicit the pathways and relationships of change, and the assumptions upon which these details are based (Killion, 2017). Given the importance of establishing these relationships and links, the initial ToC outlined the outcomes that were anticipated by teachers from their engagement in Lesson Study, and also revealed the contextual/change mechanisms or determinants which contribute to Lesson Study achieving these outcomes.

For Guskey (2005, 2012) and Killion (2017), the starting point for evaluations is to define clear outcomes that delineate specific changes that participants want and expect to achieve from professional learning and development. According to Killion (2017), failure to do so leads to evaluations erroneously focusing on completing activities and actions rather than on achievement of intended results or change. Given that Lesson Study is not an end in itself (Seleznyov, 2019), but rather a means to achieve an identified change to teaching and learning (in this case to enact specific self-identified aspects of the new primary mathematics curriculum); the identification of impact and outcomes over three cycles of Lesson Study, and the measures used to evaluate same needed careful consideration.

In terms of identifying outcomes, Guskey (2001a, 2001b, 2003) strongly advises that the levels should be looked at in reverse, starting with the outcomes for children's learning and then working back (Hirsh, 2012). This was particularly apt in the case of this study, as it brought the new curriculum and in particular, Curriculum Learning Outcomes for children to the forefront of the Lesson Study. In the case of this study, Place Value and adaptive reasoning were selected as the research theme for the Lesson Study intervention. Working backwards (Taplin et al., 2013), indicators of success (Killion, 2017) were then devised across each of Guskey's (2000) critical levels of PD evaluation, against which to determine the achievement of these outcomes [See tables 6, 7, 8, 9, 10 below].

Chen (2015) holds that interventions are most likely to succeed when the model employed is well constructed and realistic. To explicate the ToA employed in the study, forward mapping was applied. The ToA elucidates the test Lesson Study model employed. This was strongly informed by Takahashi and McDougal's (2016) Collaborative Lesson Research model [See sub-section 2.4.1 - Figure 2]. Notably, this test model of Lesson Study was also largely influenced by the time and resources available to the researcher.

Monitoring the programme theory

Chen (2015, 80) holds that for an intervention to be effective and its implementation successful "its action model must be sound and its change model plausible". Moreover, Chen (Ibid) adds that the fidelity of stakeholders' assumptions is crucial to the validity of an evaluation. Accordingly, as recommended by Donaldson (2003), plausibility checks were conducted with participants at two intervals during the intervention process. The first plausibility check was conducted with Lesson Study teams following the first cycle of Lesson Study and slight modifications were made to the initial ToC draft. The second plausibility check was conducted with participants following the second cycle of Lesson Study, but this did not result in any changes. Each plausibility check involved revisiting the initial programme theory logic model.

Similarly, while the model of Lesson Study (ToA) employed was largely predetermined and influenced by the resources available to the researcher and the school, nonetheless plausibility checks were conducted at different intervals of the evaluation to ensure that the expectations for the Lesson Study intervention were realistic and consistent. Importantly, by formulating the ToA with all participants, this also allowed for greater consistency in terms of how Lesson Study was organised and conducted across the three school research sites. Furthermore, social science research was consulted to ensure that the ToA and ToC aligned with research findings of Lesson Study interventions conducted in other contexts and settings.

3.5 Research methods

TDE is based on the premise that research methods, while important elements of an evaluation, should not dictate or drive the evaluation (Chen, 2015; Donaldson, 2007). Rather, the choice of the data collection methods was determined by the aim of the study, its scope and the conditions and contextual mechanisms determined by the teachers in the programme theory. Given that the objective of the research was to determine 'if' Lesson Study works, 'how' it works and 'why' it works; it was of interest to the researcher to pursue three lines of inquiry

(i) to investigate the impact of Lesson Study
(ii) to elucidate the process of change

(iii) to examine the test model of Lesson Study employed in the study. For each line of enquiry (evaluating the ToC) the participants were consulted on data collection methods.

The data collection and analysis methods employed for each line of enquiry are outlined in sub-sections 3.5.3, 3.5.4 and 3.5.5 respectively.

In general terms, the aim of the data collection process was to gather data that would substantiate or refute claims that Lesson Study accomplished the anticipated outcomes articulated in the ToC and reveal the Lesson Study determinants or intervening variables which contributed to outcomes at each of these levels. At the end of the evaluation period, participants perspectives of causality and relationships between the outcomes and determinants of Lesson Study were explicitly investigated using focus group interviews. Using this method, teachers drew on their direct experience as evidence to explain their perspectives. Importantly, outcomes and determinants which were not anticipated by the participants were also investigated at the end of the intervention period. These unanticipated outcomes and determinants were deduced from group interviews with teachers and they were then guided to apply the same process of evaluation to these unanticipated outcomes and determinants. The programme theory also made explicit how the model of Lesson Study was implemented in the study thus allowing it to be tested and refined. Participants were facilitated to review the overall findings collected and to summatively evaluate the model of Lesson Study employed (ToA) and their experience with TDE evaluation at the end of the evaluation period.

3.5.1 Data collection methods

For Guskey (2012, 296), how evidence is gathered is just as important as the evidence itself, insisting that evidence must be gathered in "meaningful and scientifically defensible ways". To gain a more sophisticated understanding of the impact of Lesson Study, a mixed methods approach was adopted as it allowed for a combination of both quantitative and qualitative methods to be used in a parallel way, through a triangulation of data sources (Stockman, 2016). Whilst often viewed as representing two separate paradigms, the mixture of quantitative and qualitative methodologies in this research design enabled the researcher to combine in-depth qualitative data with rigorous quantitative data so as to extend and make new claims to knowledge about the impact of Lesson Study and its merit in supporting Irish teachers to enact the new primary mathematics curriculum.

As evidenced in Chapter 4 [See section 4.2], to evaluate the outcomes, participants were asked to both quantitatively rate the extent to which success indicators were evident and to substantiate their rating with qualitative examples and explanations. Qualitative data was also gathered on teachers' summative reflections of the outcomes achieved. While quantitative data was produced from objective measures of the impact of Lesson Study on three isolated outcomes, namely teacher questioning, children's understanding of Place Value and their adaptive reasoning skills. The kind of data collected from the evaluation of the ToC was defined in terms of what could be measured from a triangulation of data sources namely; teacher self-report data, researcher observations and findings from objectives measures of impact. In selecting these research sources, the researcher adopted what mixed methods proponents Teddlie and Tashakkori (2012, 777) describe as "methodological eclecticism". Secondary data sources such as teacher journal notes and Lesson Study artefacts (lesson plans, observations records, etc.) were also gathered and served to further substantiate the findings. These data sources were chosen as they triangulated and strengthened the findings so as to deepen the readers' understanding of the impact of Lesson Study in supporting Irish primary teachers to enact the new primary mathematics curriculum.

In pursuing the other two lines of enquiry (exposing the process of change and examining the test model of Lesson Study), qualitative methods were employed with predominantly self-report data collected. Self-report data is the subject of much debate in the literature. The main criticism of self-report data and measures is that it holds limitations (Paulhus and Vazire, 2007) such as being subject to confirmatory bias and recall bias (Cook and Campbell, 1979). Chan (2009) argues that too much can be made of these limitations. Rather, the tacit nature of teaching and learning makes data collection a complex endeavour which often relies on teacher judgements (Scoles et al., 2014). There were a number of measures taken to improve the quality and reliability of self-report data collected in this study, as outlined in section 3.6.

A strong rationale for upholding and defending the use of self-report data in this study stems from its congruency with the current political agenda, in particularly in terms of contemporary democratic views of professionalism which value teacher agency and autonomy [See sub-section 2.2.5 and 2.2.6]. It is the view of the researcher that to be authentic, this research should be consistent both in addressing the aim of the research and in the methodological approach employed. Given that teachers are curriculum-instructional gatekeepers (Thornton, 1991, 2005) who "ultimately bear responsibility for implementing

curriculum reform" (Bybee, 1993, 233), it is a core tenet of the research that teachers are best placed to evaluate the PD model and process which serves to support them to enact curriculum. As such, teachers' views and assumptions as to what best reflects evidence of change in terms in their professional learning and practice and in their children's learning needs is central to the evaluation.

Selecting data sources and tools

In selecting data sources and tools, the researcher adopted a methodological eclecticism approach (Teddlie and Tashakkori, 2012). Methodological eclecticism is consistent with the pragmatist philosophical approach of the study [See section 1.2], considered to be the philosophical partner of mixed methods research (Johnson and Onwuegbuzie, 2004). As evidenced in tables 5, 14, and 16, a range of tools were selected which were deemed most appropriate for addressing individual research questions. With careful organisation and strategizing, many of the tools were designed to address different questions simultaneously. These tables also note the analysis techniques which were applied to the data collected.

The two data collection tools predominantly used in the study were focus group interviews and questionnaires. Semi-structured interviews and questionnaires were employed to generate data focused on specific topics or lines of enquiry in the study (Bryman, 2008). Given the focus that the programme theory and Guskey's (2000) framework afforded the evaluation model employed, these tools were deemed most appropriate as they allowed the researcher to focus on the three identified lines of enquiry and research questions of interest to the study, as discussed in section 3.1.

Semi-structured interviews were designed with a focused list of questions to be addressed (Bryman, 2008). Focus group interviews were conducted face-to-face so as to allow the researcher to explore a "range of opinions and the different representations of the issue" (Gaskell, 2000, 41). All focus group interviews were recorded and transcribed, serving to both ensure that the researcher could attend to the needs of the participants but also to provide opportunities to both the researcher and participants to check the accuracy of the transcription (Hinds, 2000). Creating a safe atmosphere and responding to the participants' needs was an imperative for conducting the focus group interviews (Kvale, 1996). Whilst transcription was time-consuming, a very focused approach to data collection aided in reducing the time allocated to transcription (Bryman, 2008).

Questionnaires were also employed as they are a useful method of collecting both quantitative and qualitative data (Clarke and Dawson, 1999). Questions posed in the questionnaire were directly linked to the aims and research questions (Clarke and Dawson, 1999) and were deemed a reliable method given the consistent order of questions and structure (Bryman, 2008). Questionnaires were employed mainly where Lesson Study teams or individuals were required to rate their responses to a statement. The same six-point Likert scale was employed consistently across all rating activities. Rating key: 0= not at all, 1= little or no extent, 2= to a small extent, 3= to a moderate extent, 4= to a great extent, 5= to a very great extent. Rating activities were typically followed up with space to provide written responses and explanations for the rating given.

Given the complexity of data collection using these tools (Bryman, 2008), both the semi-structured interview questions and questionnaires were piloted with academic colleagues and revised prior to administering to participants. This served to reduce the potential for collecting any unnecessary or ambiguous responses and to add rigour to the findings (Hinds, 2000). The transcripts of the focus group interview and questionnaire data produced a large amount of data for analysis. As such, sophisticated analysis tools and techniques were required.

3.5.2 Data analysis methods

The data analysis approach adopted in this study is what Teddie and Tashakkori (2009) term as parallel mixed data analysis where a separate analysis of qualitative and quantitative data takes place and the findings are combined into meta-inferences.

In terms of quantitative data, ordinal data was collected using Likert scales to determine the extent to which success indicators were evident and outcomes achieved. As outlined below, descriptive analysis was initially conducted on all quantitative data collected so as to show and summarise data in a meaningful way (Kent, 2015). Each data set was first tabulated and then visualisation techniques were employed to create graphical representations of the information collected. Radar charts were used to illustrate participants' ratings of the impact of Lesson Study. Presenting quantitative data in tandem with qualitative data helped to derive meaning from the data collected (Robson, 2011). Inferential analysis was conducted on objective measures of the impact of Lesson Study on teacher questioning and children's learning (understanding of Place Value and adaptive reasoning skills) to determine the relationship between different variables (Gibbs et al.,

2017). Bar graphs were used predominantly to illustrate the findings from these measures. Stacked bar graphs were particularly useful in conveying proportional data (Salkind, 2010). Moreover, statistical testing of quantitative data served to strengthen the rigour of the findings and to describe the relationship between variables and highlight the differences in each of the research sites (schools). To ensure the quality of statistical testing and analysis, a review of the reporting of quantitative data and statistical tests employed in the study was independently commissioned and peer validated by a fellow PhD candidate with experience in statistical data analysis.

Given the broad body of qualitative data collected over the evaluation period, it was necessary to employ a consistent and rigourous approach to analysing the data in general. Qualitative content analysis was employed which required that the researcher focus only on aspects of the data that relate to the lines of enquiry or research questions (Schreier, 2014). A category system was employed where data gathered could be defined and allocated to one or more categories (Kohlbacher, 2006). This overall approach to analysing the qualitative data collected over the evaluation period was selected as, unlike grounded theory and other strategies, qualitative content analysis allows for deductive ways of category labeling. Also, its strengths were found to lend very well to the research design and overall approach. These strengths include that (a) the data analysis is controlled methodologically, (b) all data sources are analysed step-by-step in a consistent way, and (c) it is flexible (Kohlbacher, 2006; Schreier, 2014).

Specific steps taken to employ this analytical approach were to

- Define categories of data to align with the three lines of enquiry (or research questions) (i) the impact of Lesson Study (Does it work?), (ii) the process of change (Why does it work?) and (iii) the test model of Lesson Study employed in the study (How does it work?) (Kohlbacher, 2006)
- Further categorise data pertaining to the impact of Lesson Study in terms of Guskey's (2000) five levels of PD evaluation
- Identify patterns and themes through thematic coding in the data with each category (Merriam, 2009; Clarke and Braun, 2013; Mayring, 2015), as outlined in following sections
- Arrange these themes and patterns in relation to each other (Merriam, 2009)

Individual techniques employed to analyse specific areas of investigations within each of the three lines of enquiry pursued in the study are outlined in detail in the following three sections (3.5.3, 3.5.4 and 3.5.5).

To ensure the quality of analysis, reliability checks were employed by asking an independent researcher to analyse data from one case and compare to the researcher's analysis. Comparisons of analyses found strong inter-coder reliability and small adjustments were made following deliberation. At the end of the intervention, a SWOT (Strengths, Weaknesses, Opportunities and Threats) analysis was also employed to collect and analyse summative data. The use of this analysis technique is pervasive in the literature, largely due to its simplicity (Helms and Nixon, 2010). Importantly, given that identical protocols were employed in the collection of data across each of the research sites (schools) [See sub-sections 3.5.3, 3.5.4 and 3.5.5], this allowed for comparative analysis of the configuration of findings across each research site. Each subset of data was also examined across each research site to adjudicate for differences in the findings and possible explanations for same. Importantly, by tracing the evidence across each research site, comparisons of the findings could take into account valuable contextual information (van der Veer, 2016).

3.5.3 Investigating the impact of Lesson Study

To investigate the impact of Lesson Study and determine if Lesson Study worked or was an effective model of PD to support the teachers to enact the new primary mathematics curriculum, a number of embedded research questions were explored in the study.

- Did it produce teachers' anticipated outcomes? To what extent?
- Were there unanticipated outcomes? If so, what were they? To what extent were they achieved?
- To what extent were outcomes caused by Lesson Study?
- What impact did Lesson Study have on teachers questioning?
- What impact did Lesson Study have on children's understanding of Place Value and Adaptive Reasoning Skills?

The following table provides an overview of the types of research methods adopted to investigate the impact of Lesson Study, the data sources and techniques applied in collecting the data, who data was collected from and when it was collected.

Table 5. Research methods for investigating the impact of Lesson Study

Area of investigation	Research question addressed	Type of research conducted	Data sources	With whom	When collected	Analysis Technique
Theory of Change Outcomes (anticipated and unanticipated)	Did Lesson Study produce the expected and anticipated outcomes at each level? To what extent?	Mixed	Focus Group Interview (Self-Report and rating)	Lesson Study teams (n=3)	Levels 1-3 (Post-Lesson Study) Levels 4-5 (Following each Research Lesson)	Thematic Analysis Non-parametric testing on ranking data
	Were there unanticipated outcomes? If so, what were they? To what extent were they achieved?	Mixed	Focus Group Interview (Self-Report and rating)	Lesson Study teams (n=3)	Levels 1-5 (Post-Lesson Study)	
	To what extent could outcomes be attributed to Lesson Study?	Quantitative				
Impact on teacher questioning	What impact did Lesson Study have on the types of questions that teachers posed in mathematics lessons (Open/closed)?	Quantitative	Audio-recordings of maths lessons	Individual teachers (n=1)	Four intervals 1.Pre-Lesson Study 2.During Research Lessons 3.Post-Lesson Study (1 month) 4.Post-Lesson Study (4-6 months)	Coded and statistical analysis
	What impact did Lesson Study have on the frequency of open-ended questions posed in mathematics lessons?					
Impact on children's learning	What impact did Lesson Study have on children's understanding of Place Value?	Quantitative	Criterion referenced assessment	52 children across the three schools[10]	Two intervals 1. Pre-Lesson Study 2. Post-Lesson Study	Quality rating and statistical analysis
	What impact did Lesson Study have on the quality of children's adaptive reasoning skills?		Teacher/Student Interview			
	What impact did Lesson Study have on the types of responses children provided to open-ended questions?					Coded analysis

[10] Small school n=10; medium school n=24; large school n=18

Theory of Change outcomes across five levels (Guskey, 2000)

To generate evidence of the impact of Lesson Study at each level of Guskey's (2000) framework [See sub-section 3.5.3 – Theory of Change outcomes across five levels], the teachers discussed, devised and agreed a set of success indicators for the anticipated outcomes at each level 1-5. At different intervals, (Post-Lesson Study for Levels 1 to 3 and following each Research Lesson for levels 4 to 5), the teachers were then asked to rate (from 0 to 5 using a six-point Likert scale) the extent to which each of these success indicators were evident in actuality from their experience or observation. Rating key: 0= not at all, 1= little or no extent, 2= to a small extent, 3= to a moderate extent, 4= to a great extent, 5= to a very great extent. In retrospect of their experiences at each level, the participants were also asked to include for evaluation, any unanticipated outcomes that they had experienced. Whilst these unanticipated outcomes do not feature in the initial ToC, they were retrospectively evaluated using an identical approach. In addition to rating the anticipated and unanticipated outcomes, participants were also asked to explain and contextualise their responses with qualitative commentary and examples. An example of a comment made by a teacher to a 5 rating (indicator was evident to a very great extent) was "I knew by looking at Child X that the penny had dropped and she finally understood what I was trying to explain" (Megan, Research Lesson 2).

The first critical level of PD evaluation (Level 1) is concerned with participants' reactions and level of satisfaction with various aspects of the PD experience (Guskey, 2002). This level is typically the primary focus of PD evaluations (King, 2014). Participants asserted that for Lesson Study to have 'worked' or been successful at Level 1, then two key outcomes would need to be achieved. They would need to determine that (1) Lesson Study was a worthwhile and enjoyable experience and (2) they had increased confidence to teach the new curriculum. The participants listed nine success indicators against which to measure the achievement of these outcomes and subsequently added three additional unanticipated outcomes for evaluation. The full list of outcomes and success indicators for Level 1 is presented in table 6.

Table 6. Outcomes and success indicators at Level 1

Outcomes and success indicators at Level 1

Consider Lesson Study a worthwhile and enjoyable PD experience

1. Participating in Lesson Study was enjoyable
2. Collaborating and sharing with colleagues was a worthwhile professional experience
3. Participating in Lesson Study was beneficial to our professional learning and development
4. Participating in Lesson Study was beneficial to the learning of the children
5. Participating in Lesson Study was a good use of our time

Increased confidence in using the new primary mathematics curriculum

6. We are more confident about adopting the new primary mathematics curriculum
7. We are more confident about working with broad Curriculum Learning Outcomes
8. We are less apprehensive about changes to the primary mathematics curriculum

Unanticipated outcomes

9. Lesson Study changed how we think about curriculum (its role and how we use it)
10. We found the experience affirming of our current good practice
11. We saw direct benefits for the children's learning

In addition to having a positive reaction to a PD experience, it is hoped that participants will learn something from it (Guskey, 2002). Participants asserted that for Lesson Study to have 'worked' in supporting them to enact the curriculum, then three key outcomes would need to be achieved at level 2. They would need to determine that they had (1) more familiarity with the new curriculum, (2) improved knowledge for teaching Place Value and (3) improved knowledge for supporting the development of children's adaptive reasoning. The participants then listed 16 success indicators against which to measure the achievement of these outcomes and subsequently added two additional unanticipated outcomes for evaluation. The full list of outcomes and success indicators for Level 2 is presented in table 7.

Table 7. Outcomes and success indicators at Level 2

Outcomes and success indicators at Level 2

More familiar with teaching the new primary mathematics curriculum

1. We increased our familiarity with the key aims and principles of the new primary mathematics curriculum (particularly Place Value and Adaptive Reasoning)
2. We learned how to use broad Curriculum Learning Outcomes and set realistic goals for children's learning
3. We increased familiarity with how to use the curriculum specification to guide teaching – planning, teaching and assessment of children's mathematical learning

Improved subject matter knowledge for teaching Place Value

4. We learned about common misconceptions and misunderstandings that children have with Place Value
5. We learned about the key concepts which underpin foundational learning of Place Value
6. We expanded our repertoire of teaching strategies and learning activities to support children's learning of Place Value
7. We learned how to anticipate and effectively manage children's responses to Place Value tasks and questions
8. We expanded our repertoire of formative assessment strategies and tools to assess children's learning in Place Value
9. We expanded our repertoire of differentiation strategies and tools to enhance inclusivity of learning
10. We increased our knowledge of where to source relevant teaching/learning aids and resources to support children's learning of Place Value
11. We learned a variety of different ways that children can represent their learning and understanding of Place Value

Improved pedagogical content knowledge for supporting the development of adaptive reasoning

12. We honed our skills in selecting and developing rich cognitively challenging tasks that promote higher-order thinking
13. We learned how to promote maths talk
14. We honed our skills in posing open questions that facilitate the development of children's reasoning skills.
15. We increased our understanding of how children can be supported to build their capacity for logical thought, explanation and justification (adaptive reasoning)
16. We expanded our understanding of the different ways children can clarify and determine the legitimacy of their reasoning (e.g. through discussion, presenting ideas and problems, offering reasons for the procedures and strategies they employ, etc)

Unanticipated outcomes

17. We refined how we understand and use formative assessment in their maths lessons
18. We refined what we understand quality and rich mathematical learning to look like (in the new curriculum)

At Level 3, the focus of evaluation was on organisational change and support, or more specifically the necessary organisational characteristics and attributes for success (Guskey, 2002). Lack of success at Level 3 has been found to diminish success at Levels 1 and 2 (Sparks and Hirsh, 1997), owing mostly to a lack of support to implement learning within the given organisational culture or policies (Guskey, 2002). As such, participants asserted that for Lesson Study to have 'worked' or been successful in supporting them to enact the curriculum, then three key outcomes would need to be achieved at level 3. They would need to report positive outcomes in terms of (1) support from leadership in the schools, (2) improved staff collegiality, and (3) increased sharing and collaboration among teachers. The participants then listed 16 success indicators against which to measure the achievement of these outcomes and subsequently added two additional unanticipated outcomes. The full list of outcomes and success indicators for Level 3 is presented in table 8.

Table 8. Outcomes and success indicators at Level 3

Outcomes and success indicators at Level 3

Support from leadership

1. School leaders and fellow colleagues were supportive in managing classes while Lesson Study was taking place
2. Sufficient resources (including time) were made available to allow for participation in Lesson Study
3. Sufficient space was made available to have professional conversations about children's learning
4. Useful curriculum support materials were made available to us
5. Efforts in participating in Lesson Study were acknowledged and celebrated

Improved collegiality

6. We learned more about student thinking from working together than if they had worked alone
7. We learned more about mathematical pedagogy from working together than if we had worked alone
8. Working together on mathematical lessons was enjoyable
9. Planning mathematics lessons together was useful
10. Our team relationship was characterised by trust, care and mutual respect
11. The environment for Lesson Study (team meetings and classroom lessons) was supportive
12. Lesson Study facilitated us to develop shared values, goals and/or a common vision of teaching

Increased sharing and collaboration among teachers

13. The focus for Lesson Study investigation was of value to the school
14. We were willing to give and receive both constructive feedback and reinforcement
15. We were open to planning and teaching collaboratively with colleagues in the future
16. We were open to using observations as a tool for professional development and learning in the future

Unanticipated outcomes at Level 3

17. We developed increased empathy for each other
18. We fostered better teacher/student relationships with children in the 'research' class

At Level 4, the focus of evaluation is to determine if the intervention has translated to or made a difference to participants' professional practice (Guskey, 2000). Guskey (2002) held that because enactment is often a gradual and uneven process, progress at Level 4 would

likely need to be measured at several time intervals. Accordingly, unlike previous levels 1, 2 and 3 where data was gathered at the end of Lesson Study; evaluation data at Level 4 was collected at four points of the evaluation, namely following each of the three Lesson Study cycles and at the end of the intervention. It should be noted that each teacher in the respective Lesson Study teams took it in turns to teach a Research Lesson.

Furthermore, Guskey (2002) held that specifying distinct indicators of both the degree and the quality of implementation was essential to gathering relevant information at this level. Therefore, and as with previous levels, participants devised a set of 15 success indicators against which to measure the achievement of four key anticipated outcomes. To determine that Lesson Study had supported teachers to enact the new primary mathematics curriculum in practice, the participants agreed that they would need to report that (1) they had provided of a quality, rich and inclusive learning environment for the children to learn as promoted in the new curriculum; (2) they had provided rich cognitively challenging tasks in their lessons; (3) they had facilitated the development of children's adaptive reasoning skills, a key aspect of mathematical proficiency which underpins the overarching aim of the new curriculum; and (4) they had promoted mathematical discourse or 'maths talk', another key meta-practice which is critical to enacting the new curriculum in classrooms. At the end of the intervention, the participants added four additional unanticipated outcomes at level 4 which were evaluated retrospectively using identical methods. The full list of outcomes and success indicators for Level 4 can be found in table 9.

Table 9. Outcomes and success indicators at Level 4

Outcomes and success indicators at Level 4

Provision of a quality, rich and inclusive learning environment

1. The learning environment was set up to maximise children's learning
2. Children were organised and grouped appropriately to maximise their learning
3. Realistic goals were set for children's learning
4. Appropriate formative assessment strategies and tools were employed to assess children's learning
5. All children could access learning on the topic

Provision of rich cognitively challenging learning tasks

6. Opportunities were provided for children to apply their understanding of Place Value in problem-solving situations
7. Learning tasks were selected that promote higher-order thinking (Stein, Grover, and Henningsen,1996)
8. Learning tasks were selected that provided an appropriate level of challenge for the children (Ibid)

Development of students adaptive reasoning

9. Open- questions were posed to facilitate the development of children's reasoning skills
10. Opportunities were provided for children to build their capacity for logical thought, explanation and justification
11. Opportunities were provided for children to reflect and navigate through the many concepts, solutions and methods, facts and procedures they encountered towards sense-making
12. Opportunities were provided for children to clarify and determine the legitimacy of their reasoning (e.g. through discussion, presenting ideas and problems, offering reasons for the procedures and strategies they employ, etc)

Promotion of mathematical discourse or 'maths talk'

13. Children were encouraged to engage in mathematical discourse (maths talk)
14. Less time was afforded to teacher-dominated discourse (teacher talk)
15. Opportunities were provided for children to communicate and/or represent their mathematical ideas in diverse ways

Unanticipated outcomes at Level 4

16. We used formative assessment (questioning, observing, etc.) to inform our next teaching steps
17. We taught the children from the level they were at, rather than from where we thought they 'should' be
18. We raised our expectations of children's learning and ability
19. We re-evaluated and refined our teaching style and approach

Using a similar approach to the previous level, evaluation data at Level 5 of the ToC was also gathered at four points of the study (following each of the three Lesson Study cycles and at the end of the intervention). Evaluating PD at Level 5 addresses the impact that PD has on children's learning, what Guskey (2016, 35) describes as "the bottom line in education". Participants asserted that to determine that Lesson Study had been successful in supporting them to enact the curriculum, two key outcomes for children's learning would need to be achieved at level 5. They would need to need to report that (1) the children had achieved learning goals linked to a new Curriculum Learning Outcome for 'Place Value' introduced in the new primary mathematics curriculum for infant classes; and (2) that children had developed their adaptive reasoning, a key aspect of mathematical proficiency, the overarching aim of the new curriculum. Participants devised a set of 15 success indicators against which to measure the achievement of these two anticipated outcomes. At the end of the intervention, the participants added four additional unanticipated outcomes at level 5 which were evaluated retrospectively using identical methods. The full list of outcomes and success indicators for Level 5 can be found in table 10.

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Table 10. Outcomes and success indicators at Level 5

Outcomes and success indicators at Level 5

Learning goals linked to Stage 1 Learning Outcome for Place Value in the new Primary Mathematics Curriculum

1. They made a connection between their prior and new learning on the topic (Place Value)
2. They explored the relationship between numbers 1-9 and their association with 10
3. They explored the structure of numbers in terms of tens and units
4. They used appropriate language to discuss the grouping and/or exchanging/swapping of objects or numerals
5. They explored appropriate mathematical representations to communicate ideas of tens and ones
6. They recorded their understanding of Place Value concepts using concrete materials or pictorially
7. They composed and/or decomposed numbers into tens and ones using appropriate materials
8. They explored various arrangements of objects to prompt different mental images of numbers and various mental strategies for manipulating these numbers
9. They engage in playful learning of place value using concrete and/or base ten materials
10. They participated in grouping and/or swapping activities involving tens and ones
11. They solved problems through play involving grouping and/or swapping around 10

Adaptive reasoning

12. They reflected on the place value ideas, facts, methods and procedures presented in the lesson
13. They made attempts to explain their understanding
14. They communicated and represented their ideas, problems and solutions in multiple ways
15. They offered plausible reasons for the procedures and strategies they employed

Unanticipated outcomes at Level 5

16. They improved their language and verbalisation skills
17. They were more confidence and willing to 'give it a go'
18. They were open and receptive to different teaching styles
19. They collaborated effectively with their peers

Objective measures of impact

To triangulate the findings from the evaluation of the ToC and mitigate against potential limitations of the predominantly self-report data collected, objective measures (i.e. non self-report measures) of the impact of Lesson Study on teacher practice and on children's

learning outcomes were included in the study. Specifically, three anticipated outcomes detailed in the ToC were isolated and measured; namely teacher questioning (Level 4), children's understanding of Place value (Level 5), and children's reasoning skills (Level 5), were isolated and subjected to further evaluation using objective measures.

Teachers' questioning

Participating teachers explicitly stated that in order to deem that Lesson Study had been successful in supporting them to enact the curriculum, one of the key outcomes in their teaching practice (Level 4 of the ToC) would be the facilitation or development of children's reasoning skills. Higher-order questioning is widely held in the literature as playing a critical role in the development of children's critical thinking and reasoning skills (Tienken et al., 2010; Walsh and Sattes, 2010; Nappi, 2017). As such, it was of interest to this research study to investigate the impact of Lesson Study, if any, on teachers' questioning. Specifically, the investigation sought to determine teachers proportionate use of different question types, and to measure the frequency of open-ended questions posed by teachers in maths lessons, across four evaluation points.

With the exception of the Research Lesson, which was audio recorded by the researcher, the teachers were asked to record themselves at three separate intervals over the course of the evaluation. Before Lesson Study commenced, the teachers were asked to record a typical 20-30 minutes maths lesson. The teachers were asked to record again one month following the completion of Lesson Study and again in the following term, approximately 4-6 months post-Lesson Study. Teachers were told that the researcher would be examining and evaluating 'teacher talk' during the recording but no further specification was provided as to what exact measures of teacher talk would be investigated. The reason for this was to mitigate, as best possible, against unauthentic questioning or ostentatious performance.

Questions posed by teachers during the audio-recorded lessons were first categorised and filtered initially using Blosser (1973) four types of questions: (1) open, (2) closed, (3) rhetorical, and (4) managerial. Open and closed questions were classified based on Bloom's revised taxonomy by Anderson and Krathwohl (2001) to distinguish questions that required higher-order thinking (Creating, Evaluating, Analysing and Applying) and questions that required lower-order thinking (Understanding and Remembering). Rhetorical and managerial questions were eliminated for analysis as these types of questions focus on attracting children's attention and managing classrooms rather than eliciting children's

reasoning processes (Kim, 2015). Finally, a conceptual framework for analysing and coding these eligible question types was employed (Kim, 2015).

The closed-ended question category consisted of two types of questions:

1. asking for factual information **[AI]**
2. asking for confirmation **[AC]**

The open-ended question category consisted of three types of questions:

1. asking for explanation based on experience/data **[AE]**
2. asking for self-evaluation of reasoning **[AF]**
3. asking for evaluation of other's reasoning **[AFO]**

Table 11. Conceptual Framework for analysis of teacher question types (Adapted from Kim, 2015)

Category	Description	Analysis code	Description for code
Closed Question	Elicits factual information or confirmation	Asking for factual information **(AI)**	Questions requires factual information without reasoning
		Asking for confirmation **(AC)**	Question requires confirmation without reasoning
Open Question	Elicits children's adaptive reasoning *(Adaptive reasoning defined as the capacity for logical thought, reflection, explanation, and justification – (NRC, 2001; NCCA,2017)*	Asking for explanation based on experience, evidence or data **(AE)**	Question required explanation based on experience or data. *(Explanation defined as attempt to provide a reason or justification for action or belief)*
		Asking for self-evaluation of reasoning **(AF)**	Question requires self-evaluation of one's own ideas
		Asking for self-evaluation of others' reasoning **(AFO)**	Question requires self-evaluation of others' ideas

Children's understanding of Place Value

The Curriculum Learning Outcome for Place Value 'Through appropriately playful learning experiences children should be able to develop a sense of ten as the foundation for place value and counting[11]'was selected by teachers for investigation with Lesson Study. To

[11] Strand: Number. Stage: 1. Learning Outcome Label: Place Value

determine if the Senior Infant children (typically aged 5-6 years) in the research classes in each school had achieved or made progress with this outcome, the nine teachers in this study devised an agreed set of four learning criteria or targets against which to measure the quality of children's understanding of Place Value with greater confidence and consistency. The criteria set out in the following table guided the design of a criterion referenced assessment which sought to assess the quality of children's understanding of Place Value.

Table 12. Criteria for assessing children's understanding of Place Value

The child can	
Criterion 1	Appreciate that the position of a digit indicates its value – that digits to the left have the greatest value, digits to the right have the least
Criterion 2	Model and represent the value of a two-digit number (between 11-19) to communicate the idea of tens and units
Criterion 3	Identify and write the number that is 1 more, 1 less, 10 more than a two-digit number (between 11-19)
Criterion 4	Compose and decompose a two-digit number (between 11 -19) into tens and units

The following is a screenshot of the criterion-referenced assessment tool assessment designed and administered in the study.

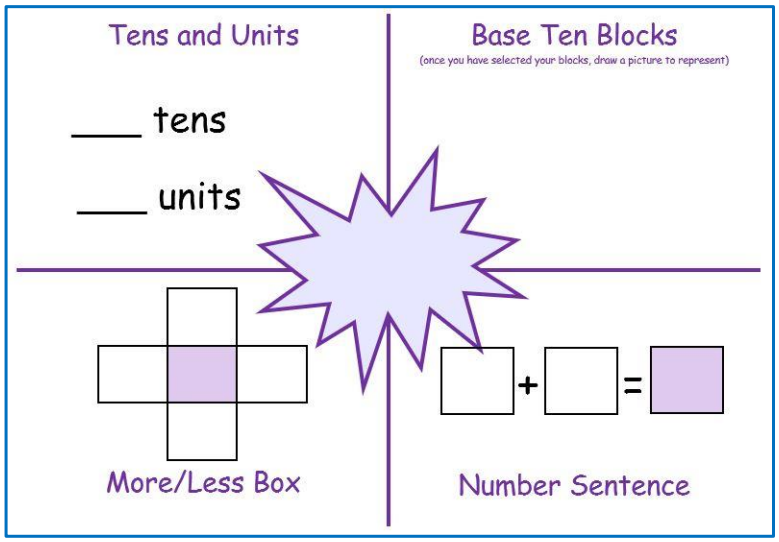

Figure 5. Pre and Post Intervention Criterion-Referenced Assessment of Place Value (Instrument)

Senior infant children in all three schools completed the assessment on two occasions – pre-Lesson Study and post-Lesson Study. The assessments were scored independently by the researcher on both occasions. Full scores (2) were awarded for full achievement of a criterion, partial scores (1) were awarded for partial achievement of a criterion, and no scores (0) were awarded where children did not demonstrate any achievement of a criterion. As with other data collected in the study, this data was analysed and compared across schools.

Children's adaptive reasoning skills

In addition to investigating the children's understanding of Place Value, the teachers conducted a short interview with each of the senior infant children in the research class pre- and post-Lesson Study. In the interview, the children were asked three open-ended questions specific to the criterion-referenced assessment they had just taken [See table 13 below]. The objective of this teacher/student interview was to evaluate children's reasoning skills in responding to open-ended questions posed by the teachers. The three interview questions posed asked for both explanation and self-evaluation of reasoning.

1. Why did you choose/write that number? (Asking for explanation)
2. How do you know that's right? (Asking for self-evaluation of reasoning)

3. What is the same/different about each task? (Asking for explanation)

Correspondingly the responses to these questions aligned with criteria of 'higher-order' adaptive reasoning skills, set out in the following table, which comprised the measures to determine the quality of children's adaptive reasoning skills.

Table 13. Criteria for assessing children's adaptive reasoning skills

The child can	
Criterion 1	Explain why they chose a particular number, strategy or solution to justify their answer
Criterion 2	Justify their solutions with plausible reasons
Criterion 3	Think logically about the relationship between different representations of a number using place value concepts

Through teacher / student interviews, the exact responses of children to each individual question were recorded and then subsequently scored independently by the researcher. Responses were coded according to two categories of cognition, lower-order and higher-order thinking (Kim, 2015). Once coded, two layers of analysis were applied to the responses and they were then compared pre- and post- Lesson Study. Firstly, to determine if there had been a change to the quality of children's reasoning skills and secondly, to determine if there had been any change to the types of responses made.

In the first incidence, the responses were scored according to the extent to which they met the criterion of children's 'higher-order' adaptive reasoning skills in response to these aforementioned open-ended questions. Full scores (2) were awarded for full achievement of a criterion, partial scores (1) were awarded for partial achievement of a criterion, and no score (0) was awarded where children did not demonstrate any achievement of a criterion. As with other data collected in the study, this data was analysed within and compared across cases.

3.5.4 Exposing the process of change

To expose the process of change and address why Lesson Study worked or was effective in achieving the impact established in the study, a number of embedded research questions were explored in the study. The following table provides an overview of the types of research methods adopted to expose the process of change which results in the achievement of these Lesson Study outcomes. Moreover, it outlines the data sources and

techniques applied in collecting the data, who data was collected from and when it was collected.

Table 14. Research methods for exposing the process of change

Area of investigation	Embedded research question addressed	Type of research conducted	Data sources	With whom	When collected	Analysis Technique
Theory of Change Determinants (anticipated and unanticipated)	What aspects of Lesson Study (determinants) could be attributed to the outcomes established in the study?	Qualitative	Questionnaire (Self-report and rating) Focus Group Interview (Self-Report, categorisation and ranking)	Lesson Study teams (n=3) Full participant cohort (N=9)	Post-Lesson Study	Qualitative Content Analysis
	Were there unanticipated determinants? If so, what were they?		Focus Group Interview (Self-Report)	Full participant cohort (N=9)		
	What aspects of Lesson Study (determinants) were most and least responsible for the outcomes established in the study?					
Summative evaluation	What other contextual factors influenced the outcomes of the intervention?	Qualitative	Focus Group Interview (Self-Report)	Full participant cohort (N=9)	Post-Lesson Study	Qualitative Content Analysis

Commented [TC4]: Part of Correction 5
Text below and section 4.2. para 4 adjusted also

To determine *why* Lesson Study works, the determinants or causal factors which participants anticipated would contribute to the achievement of these anticipated outcomes were evaluated. To do so, teachers devised a list of Lesson Study determinants (or aspects of Lesson Study) which the teachers believed would cause or contribute to the successful achievement of outcomes. As before, at the end of the intervention, teachers were also asked to reflect on their experience with Lesson Study and retrospectively add any additional determinants which they had not anticipated but which they concluded were important to include in the evaluation and append to the refined list of determinants. Whilst these unanticipated outcomes and determinants do not feature in the initial ToC, they were retrospectively evaluated in an identical way by asking teachers to provide qualitative commentary and examples to support their claims.

In addition to rating specific success indicators for each of the outcomes, the participants were also subsequently asked to rate the extent to which Lesson Study ' in general' could be attributed to the overall achievement of outcomes at each of the five levels of evaluation, using the same rating key (0= not at all, 1= little or no extent, 2= to a small extent, 3= to a moderate extent, 4= to a great extent, 5= to a very great extent). In selecting this rating, they were asked to consider their general experience of participating in Lesson Study and the qualitative feedback shared by their fellow Lesson Study team members during the intervention and evaluation process. This method of data collection generated a large volume of data which showed strong similarity across Lesson Study teams. Accordingly, to provide for a more explanatory data-set, the participants were also asked collectively at the end of the evaluation to categorise and rank Lesson Study determinants in terms of their contribution to outcomes at each of the respective levels.

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Text in Section 4.2. para 4 adjusted also

Lesson Study teams categorised these determinants according to three predetermined categories - 'most responsible', 'least responsible' and 'not responsible' according to their experience with Lesson Study, to determine causal attribution for success at each level of evaluation. They also selected three determinants which they considered to be most critical to success at each level. By evaluating Lesson Study in this way, the study intended to open the 'black box' of evaluation, a distinguished feature of theory-driven evaluations, to offer a comprehensive explanation as to the process by which the outcomes occurred during and as a result of Lesson Study. The outcomes and success indicators are specific to each level and are outlined in the upcoming relevant sections. A list of Lesson Study determinants, presented here in table x, was universally applied in determining causal attribution across all levels. This list comprises the causal theories based on substantive hypotheses, which

were carefully developed in collaboration with participants. Accordingly, causal inference claims derived from this study were theoretically driven.

Table 15. Determinants of Lesson Study success (across all levels of evaluation)

List of Lesson Study determinants

List of Lesson Study causal factors anticipated by teachers to be most likely to be attributed to the achievement of outcomes across all levels. One additional determinant was added to this list retrospectively on refining the Theory of Change (ToC).

Anticipated Determinants

A. Time and space (to think about teaching and assessment ideas)
B. Opportunities to share and reflect
C. Working with 'Knowledgeable Other'
D. Facilitated discussions
E. Investigating practice
F. Trying out new teaching ideas and strategies
G. Observing Lessons in 'real time'
H. Having professional conversations around the Research Lesson
I. Working collaboratively with colleagues
J. Planning collaboratively
K. Gaining the benefit of the collective knowledge and expertise of peers
L. Building on children's prior knowledge and misconceptions
M. Analysing and evaluating children's responses to teaching activities and instruction
N. Teacher toolkit (curriculum support materials)

Unanticipated determinant

O. Directly seeing progress in children's learning

Note: Determinants were lettered solely to allow for cross reference across levels of evaluation.

Further to these measures, teachers were also asked to reflect and suggest other explanations for causal attribution and consider possible inhibitors to achieving greater success at each level. Moreover, in the absence of a control group, participants were also asked to substantiate their summative feedback by estimating the counterfactual by postulating how they think their experience may have differed if a more traditional model of PD had attended the new primary mathematics curriculum. A variety of analytical techniques were employed to gather this data including contribution analysis, key informant analysis and modus operandi. This data was then analysed through the lens of causal inference to determine the extent to which this impact derived from the study can be attributed to Lesson Study.

3.5.5 Examining the test model of Lesson Study employed

The following table provides an overview of the types of research methods adopted to examine the test model of Lesson Study employed in the study and address how Lesson Study worked in the study. It also outlines the data sources and techniques applied in collecting the data, who data was collected from and when it was collected.

Table 16. Research methods for examining the test model of Lesson Study

Area of investigation	Research question addressed	Type of research conducted	Data sources	With whom	When collected	Analysis Technique
Theory of Action (test model of Lesson Study implemented)	What were teachers' individual experiences with Lesson Study?	Qualitative	Question-naire	Individual Teachers (n=1)	Post-Lesson Study	Thematic Analysis
	What were teachers' collective experiences with Lesson Study?		Focus Group Interview (Self-Report)	Lesson Study teams (n=3)		
	What were teachers' summative evaluation of the model of Lesson Study implemented in the study?		Focus Group Interview (Self-Report)	Full participant cohort (N=9)		SWOT Analysis
Summative evaluation	What were teachers' individual experiences with Lesson Study?	Qualitative	Question-naire	Individual Teachers (n=1)	Post-Lesson Study	Thematic Analysis
	From the participants' perspectives, what are the optimal conditions needed for Lesson Study to be effective in supporting curriculum enactment?		Focus Group Interview (Self-Report)	Full participant cohort (N=9)		Qualitative content analysis

A SWOT analysis framework activity is an activity familiar to Irish teachers as it is widely used for mandatory school self-evaluation purposes. The acronym SWOT follows the following key: S=Strength, W= Weakness, O=Opportunities, T=Threats (Polat et al., 2019). Using this framework, teachers were asked to consider the strengths of the Lesson Study model and any weakness that teachers identified about its implementation. Moreover, teachers were asked to consider external opportunities and threats to implementing Lesson Study in Irish primary schools on a broader scale. With this activity, the role of the researcher was to gain consensus among the participant group as to the key strengths, weaknesses, threat and opportunities of the Lesson Study model implemented in the study by means of facilitated discussion. Where there was disagreement, this point was not included in the findings.

3.5.6 Gathering perspectives on theory-driven evaluation approach

Given the novelty of the approach adopted in evaluating Lesson Study in this context, the research study also attended to participants' perspectives on TDE by asking them

- Was theory-driven evaluation an effective approach to evaluating the teachers' PD (Lesson Study) in this case?
- Was there merit in embedding evaluation into the intervention?

These questions were posed to the full cohort of participants at the end of the final data collection day as part of a series of short group interviews. Using an identical approach, a SWOT analysis activity was conducted with participants which offered insights into teachers experience with and perceptions of the strengths and weakness of Theory-driven Evaluation (TDE) and the opportunities and threats to its utility as a framework for PD evaluation.

3.5.7 Refining the programme theory

In addition to guiding the evaluation of Lesson Study, the ToA and ToC also offered a hypothesis that could be tested and result in refined theory. A refined programme theory (ToA and ToC) is a key output of theory-driven evaluations that holds particular importance for policy, decision making and practice (Donaldson, 2013; Chen, 2015). Key questions which guided the development of the initial programme theory and refinement of the programme theory in this research study are presented in the following table.

Table 17. Key guiding questions for refining the programme theory

	Initial programme theory	**Refined programme theory**
Theory of Action	What do the Lesson Study teams expect the Lesson Study process to be like? to look like?	What was the actual Lesson Study process like?
Theory of Change	How do the Lesson Study teams plan/expect the intervention to work?	How did the actual intervention work?

To refine the Theory of Change or more specifically, the substantiated outcomes and determinants of change for enacting the new primary mathematics curriculum (as determined by the teachers involved in the study), the participants were asked to consider the collective feedback shared over the period and make explicit edits and refinements to the initial ToC [See sub-section 3.4.1 - Figure 4]. Given that the initial ToC was tested and rigorously scrutinised and evaluated in the study, the refinement of the ToC is grounded in empirical evidence and thus considered to outline substantiated outcomes and determinants for supporting teachers to enact the new primary mathematics curriculum.

In terms of refining the ToA, a SWOT analysis of the test model of Lesson Study employed in the study was firstly conducted with participants to gather evidence of the strengths and weaknesses of the initial ToA. Building on these discussions, to gather participants' suggestions for improving and refining the overall ToA, participants were similarly asked to reflect on their experiences of Lesson Study and consider the collective feedback shared by the group. The purpose of the refined ToA is to articulate a favourable implementation model of Lesson Study which, according to the participants, would best support teachers to enact the new primary mathematics curriculum.

3.6 Methodological rigour and robustness

A number of strategies were adopted in this study to strengthen the robustness of the evaluation and methodological rigour in collecting and analysing the research data which are discussed in the following sections. Given the nature of the research study and in particular the prominence of teachers' voice and agency in the design of the programme theory and evaluation of Lesson Study, it was important to address inter-subjectivity and bias. Thereafter, a number of key steps taken to enhance the reliability of data and findings

are outlined. Finally, ethical and procedural issues are discussed, including the steps taken to mitigate against same.

3.6.1 Ethical and procedural issues

According to Mills et al. (2010), the need for researchers to anticipate ethical and procedural issues in the research field is especially pronounced in multi-site case studies. The researcher adhered closely to university policy and guidelines (BERA, 2018; University of Lincoln, 2018) in ensuring transparency and preventing ethical difficulties from arising. Moreover, these ethical guidelines and policy were adhered to in recruiting the research sample; ensuring participants' rights and gaining consent; and ensuring anonymity and data management. Of particular consideration was the professional role of the researcher and ensuring that this did not cause any threat to the integrity of the study.

Researcher role

As described in section 1.3, researcher positionality was a core ethical consideration of this study. The researcher was particularly cognisant of her professional role as a curriculum developer and in particular, the conflict of interest this may pose for participants in giving their honest opinions of the new primary mathematics curriculum and the merit of Lesson Study to support its enactment. In the research study, the researcher also occupied the role of facilitator and evaluator of the Lesson Study intervention. In accordance with the general ethic of transparency which permeated the evaluation, the professional role of the researcher was outlined to the participants in advance of the study commencing. From the outset and throughout the study, any issues arising which may have suggested a conflict of interest were dealt with promptly and efficiently. It was explained to participants that they were in no way obliged or expected to report positively about their experiences and/or of the new curriculum.

Throughout the study, the researcher was conscious of the potential influence of her position, the values and beliefs underpinning the questions posed and not posed (Agee, 2009), the data collected, and subsequent analysis of the data (Bryman, 2008). In contrast to traditional approaches to evaluation where all too often power relations, values and norms are typically hidden or ignored (Barnett, 2015), in the spirit of ethics and transparency, these were also openly discussed from the outset of the evaluation and throughout.

To strengthen the trustworthiness and robustness of the programme theory, the researcher acted as facilitator to outline the salient issues to be discussed as part of the intervention. Distinctions are made in the discussion chapter between findings that were reported and findings that we observed by the researcher. Self-reported outcomes, success indicators, and determinants, as articulated in the programme theory, were defined by the teachers themselves. Where disparities were evident between participants self-reported claims and the research literature, this was probed and explored with participants. Participants were encouraged to reflect on experiences, research artefacts and empirical evidence to determine their evaluation of Lesson Study (Chen, 2015). Moreover, regular plausibility checks enabled participants to further input and shape the evaluation (Donaldson, 2003).

Not to belie the apparent simplicity of the methods adopted in the study, the researcher applied sophisticated facilitation skills in generating data in the evaluation. According to Patton (2002, 2), the quality of data generated in an evaluation relies strongly on the "methodological skill, sensitivity, and integrity of the evaluator" to systematically and rigorously conduct the evaluation. The researcher was careful to communicate clearly, clarify goals and outcomes; and devise realistic and tangible goals. Unanticipated and unintended outcomes from the study were explored and clarified with participants. In terms of facilitating the evaluation, the researcher's professional role was an advantage in this way; as it contributed to the skills, knowledge, creativity and discipline required by researchers to generate useful and credible qualitative findings from the observations, focus group interviews and qualitative content analysis conducted on the data generated in the study (Patton, 2002).

Recruiting the sample

Owing to the diverse demographic of primary schools in Ireland, the main difference between the schools selected to participate in the study was school size [See sub-section 3.2.2]. Additionally, it was important that insofar as possible, a relatively representative sample of teachers were involved in the study to allow for inferences about the population to be made (Kemper et al., 2003). In recruiting schools to participate, the researcher specified that the Lesson Study team in each school should be comprised of teachers with different levels of experience, backgrounds, concerns, attitudes and interests. Typically, where a representative sample is used, the average causal effective observed in the sample tends to hold across others in the population (Cook and Campbell, 1979). The principal of

each school invited teachers to elect to participate in the study. As evidenced in Appendix 7, the profile of teachers participating in the study shows a diverse range of teaching experience and levels of confidence in teaching mathematics. Participants were informed that substitutions could be made to the Lesson Study teams at the teachers' and school principals' discretion. This would allow for unexpected disruptions to the sample composition, for example sickness or maternity leave. The researcher requested that in this case, every effort would be made to ensure that the substitute teachers' experience and teacher profile resembles the original team member, insofar as possible. Of note, the composition of the Lesson Study teams did not change over the course of the evaluation.

Anonymity and data storage

It was explained to the participant sample that due to the nature of the study, anonymity among the participants or within their school setting could not be guaranteed, however all findings would be anonymised in the presentation and/or publication of findings. Given the ethical responsibility of the researcher to the participants, pseudonyms were used in the study to protect participants' identity and to offer confidentiality (Kaiser, 2009). Furthermore, participants were advised that data pertaining to children (collected as artefacts during the study), should be appropriately anonymised. Assessments and interviews with children were administered and collected by the teachers. Each assessment / interview script was coded so that the children were unidentifiable to the researcher.

In accordance with Data Protection legislation in Ireland (2019 – see www.dataprotection.ie), personal data will only be retained for the identified purpose for which it is process, in this case until after the thesis has been passed. In the spirit of ethics and transparency and in accordance with the University of Lincoln's Research Ethics Policy (University of Lincoln, 2018) and BERA Ethical Guidelines for Educational Research (2018), all anonymised data will be retained for three years to allow for cross checking by other researchers and in the case of requests to investigate bias. Only anonymised and disaggregated data will be archived and shared with other researchers. Digital data has been coded and stored in password protected cloud space to minimise the possibility of identifying participants. After three years all hard copy and digital data will be destroyed permanently.

Participants rights and consent

Seeking permission and obtaining voluntary participation and informed consent from research participants is critical to ethical research (Wilkinson, 2001). In the spirit of transparency and ethical conduct, the researcher visited each research site (school) in advance of the intervention taking place, to meet with the participating teachers and their school principals and discuss the evaluation process and procedures that would be taking place over the period. To ensure that participants were fully aware of their rights; an information, ethics and consent form that was provided to participants on this visit to the school (Wilkinson, 2001; Bryman, 2008). This form outlined the nature of the study; the researcher's positionality, research questions and aims; and an outline of the process and procedures that would take place over the evaluation period [See Appendix 1]. This form also advised participants that their participation in the study was voluntary, with no obligation to participate and full right to withdraw at any stage of the study. On the first day of the intervention/evaluation, an oral briefing was provided to the full cohort, again reiterating the key points pertaining to ethics and participants rights. Participants then gave their signed consent at the end of this form.

Honestly and authenticity

Given the prominence afforded to teacher agency and the use of self-report data in the study, the critical importance of participants being honest and authentic in responding to research questions was strongly emphasised from the outset of the study and reiterated throughout the evaluation process. It was explained to participants that they were in no way compelled or encouraged to put forward views that did not reflect their genuine opinion, but rather that the honesty and transparency of their views were central to the rigour of the findings. This was especially stressed given the researchers professional role.

Just as the participants were encouraged to engage in the evaluation in an honest, authentic and critical way, so too was the researcher committed to engaging with the data critically so as to best reflect the views of the participants conveyed in the study.

Funding

Funding was provided to schools to incentivise the school principal and teachers to participate in the study. On completion of the study, each school received a grant of €1000.

Furthermore, substitute cover to release teachers from their classroom to engage in three cycles of Lesson Study was provided to the schools. This was funded by the NCCA who offer support for research that is of particular interest to curriculum development. Each school principal had an allocation of nine days substitute cover. Release time outside of this substitute cover provision was facilitated by the school principal and wider staff community.

3.6.2 Inter-subjectivity and bias

A natural concern where participants have much of the control over determining the evaluation and data collection process is the reliance on teacher inter-subjectivity or shared understanding. Data gathered essentially captured the shared perception of reality of the teachers who comprised the Lesson Study teams. As such, the research relied strongly on teachers professional capital and the effectiveness of teachers to demonstrate a high level of inter-subjectivity and professional agency to make fair and accurate judgements. In this study, teacher inter-subjectivity is made transparent to readers through the articulation and evaluation of the programme theory. To remove possible discrepancies and increase plausibility and rigour, all drafts of the programme theory were presented to participants for approval and consensus. By ensuring that the programme theory was plausible and manageable; the risk of arbitrariness, unwarranted subjectivity and superficiality was reduced (Donaldson, 2003). Given the reliance on inter-subjectivity, there was also a risk that the accuracies or professional judgements made by the participants may be biased. To alleviate this possibility, teachers were encouraged to make individual reflections in a dedicated notes journal and offer individual testimonials of their views and experiences.

No research study designs are immune to bias. However, researchers can take steps to attempt to minimise the potential for bias (Norris, 1997). For Camfield et al. (2014), the underlying principles for tackling bias at the level of individual evaluations are being systematic, transparent and reflexive. One of the most potent ways to minimise bias is to outline for the reader, the potential sources of bias, thus enabling greater critical evaluation of the findings and conclusions drawn (Morse et al., 2002) and greater utility of the results (Galdas, 2017). In the context of this study, the three mains sources of potential bias were at the level of research design, group feedback and data analysis.

To mitigate against design bias, plausibility checks of the programme theory were conducted with the participants. Moreover, in evaluating Lesson Study, the researcher

incorporated opportunities into the evaluation process for participants to discuss unanticipated outcomes, unanticipated determinants of change, and alternative explanations for outcomes in the study. To mitigate against analysis bias, the researcher was especially conscious not to seek data that would confirm their hypothesis or that would confirm their personal beliefs or experience. Moreover, objective measures of teachers' practice and children's learning were taken to triangulate findings on the impact of Lesson Study. In both designing the research study and questions and in analysing the data, academic peers and researchers were solicited to conduct an independent unbiased analysis of each main data set. As a result of this additional layer of analysis, adjustments were made to the research design, questions and findings where advised. Finally, to mitigate against potential confirmatory bias that may have affected the group responses from Lesson Study teams, the participants were consulted throughout the study to check for the fidelity and credibility of evidence. Participants had the opportunity to give individual feedback and testimonies of their personal experiences with Lesson Study at the end of the evaluation.

3.6.3 Reliability of findings

Whilst bias is important to address, Morse et al. (2002) hold that it is arguably more important to adopt strategies and take steps to strengthen the reliability of qualitative research data. Accordingly, given that rigour and trustworthiness are central to the reflexive, subjective nature of qualitative research (Galdas, 2017), a number of other strategies and steps were also taken to strengthen the reliability and validity of the data and findings drawn from this evaluation study.

Inter-rater and inter-coder reliability

One of the most extensively used techniques for strengthening the rigour and trustworthiness of data and findings is inter-rater and inter-coder reliability; and agreement or investigator triangulation (Lincoln and Guba, 1985). In this study, inter-rater and inter-coder reliability of the data analysis was achieved by asking a number of capable peer researcher to independently analyse the raw data without negotiation. Initial inter-rater agreement of scores of children's performance on Place Value and adaptive reasoning assessments were 81.7% and 88.5% respectively. Later inter-rater agreement on the data sets were reconciled through discussion of discrepancies that arose and resulted in greater

inter-rater reliability (94.2% and 93.6%) and consensus as to the findings generated from the data. Similarly, calculations of inter-coder agreement on initial analysis of teachers question types and children's responses to open-ended questions showed strong consensus of 88.2% and 89.6% respectively. Following discussion, some codes were adjusted increasing the inter-coder agreement further to 94.5% and 96.0% respectively.

Moreover, to ensure that the key discussion points identified in the study reflected the salient findings which emerged from the evaluation, an external researcher was solicited to conduct an independent analysis of the findings. The number of discrepancies in the salient points identified between the researcher and the external researcher was low. Notwithstanding, these discrepancies were discussed and justified in relation to the raw data collected. These measures serve to mitigate against accusations of analysis bias and add rigour to the overall evaluation results.

Consistency across research sites

Given that there were three research sites in this case study, to enhance the quality of research data the researcher employed a strictly consistent approach to evaluating Lesson Study across each site (Mills et al., 2010). Lesson Study was implemented and evaluated consistently across each of the schools, applying the same protocols in an identical way. The same resources and tools were provided to participants at each site. The process for collecting and analysing data collected from each data sources was consistent regardless of the research site. For example, the semi-structured interviews of Lesson Study teams at each school were identically conducted. Equally, the questions posed to participants in the respective interviews were identical. Furthermore, where teachers were tasked with collecting data from the children in the research classes, for example the pre/post assessments and interviews, clear and consistent instructions were provided to each participant describing how to administer and conduct this data collection. This identical and consistent approach further served to give significance to the comparisons made in the study.

As reported by other evaluation researchers, the drafting of the programme theory was time-consuming (Chen and Rossi, 1992, Donaldson, 2007) in this study. This is an inevitable and unavoidable consequence of taking a theory-driven evaluation approach (Donaldson, 2007). However, Guskey's framework (2000) was very useful to structure and focus the development of the programme theory as well as in conducting the evaluation itself.

Guskey's (2000) evaluation framework is a well-established, in-depth and thorough approach to the evaluation of PD in research studies (Goodall et al., 2005). In addition to helping to structure and focus the evaluation, it also served to ensure consistency across each of the research sites.

In terms of managing discrepancies from findings derived from different research sites, it was an imperative of the study to synthesise discussions and ascertain agreement within and across the Lesson Study teams in evaluating the overall programme theory. Where disagreement or conflict was evident in the feedback or evaluations of one or more Lesson Study teams, this was treated as further additional hypotheses to be tested or explored with the participants (Donaldson, 2007; Chen, 2015).

Meaningful comparisons

According to Guskey (2016), one of the most potent ways of enhancing the methodological rigour of an evaluation study is to plan for meaningful comparisons. To enhance the rigour of the evaluation of Lesson Study in this case, three schools were included in the study. The rationale for the selection of these schools is discussed in greater detail in sub-section 3.2.2. Suffice it to say, whilst the inclusion of three schools did not negate the risk that extraneous factors might influence the findings, it was intended that this would allow for greater confidence in attributing the findings to Lesson Study (Guskey, 2017).

According to Chen (2015), the best way to mitigate against threats to the validity of results is the inclusion of a comparison group which ideally involves the random assignment of children, teachers, or schools to different groups. However, because that is rarely possible in most education settings, finding similar classrooms, schools, or school districts provides the next best option. In terms of making comparisons in this study, all schools or Lesson Study teams focused on the same research theme and Research Lessons took place with a senior infant class in their respective schools [See section 3.2]. Importantly, the research theme selected in the study further enhances the trustworthiness of the programme theory and findings of the impact of Lesson Study at Level 5 of Guskey's (2000) framework (children's learning outcomes), as both Place Value and adaptive reasoning are novel features of the new primary mathematics curriculum. In particularly, given that senior infant children in Ireland are not explicitly taught Place Value or adaptive reasoning and as such, would not have received explicit instruction in either areas outside of Research Lessons (Lesson Study); this adds confidence to the differences determined in children's

performance on pre- and post- Lesson Study assessments of Place Value and adaptive reasoning skills.

Triangulation

In analysing the data, information from different sources was converged so that findings could be cross checked (Bryam, 2008), compared and contrasted. In doing so, the findings generated across each of the research sites were triangulated to strengthen internal validity and reliability of the findings (Cohen et al., 2000). Triangulation is a rigorous methodological approach employed to strengthen the robustness of research studies and evaluations (Salkind, 2010). Good research practice irrespective of the philosophical, epistemological, or methodological orientation of the researcher, is to use multiple methods and sources of data to enhance the validity and defensibilty of research findings (Mathison, 1988) and to deepen understanding of a phenomenon (Patton, 1999).

By its nature, the mixed methods research design employed in this study served to triangulate the data and findings, and in doing so provide a deeper understanding of the merit of Lesson Study in the context of supporting curriculum enactment (Patton, 1999). Moreover, by adopting both approaches, the research was able to compensate for the weaknesses in each individual approach (Salkind, 2010). To illustrate, objective measures were taken of the impact of Lesson Study on isolated elements of teachers' practice and children's learning, to triangulate and add robustness to the findings and mitigate against concerns about the reliability (Muckler and Seven, 1992), accuracy and validity of teachers self-reporting of their own practice (Koziol and Burns, 1986).

Methodological triangulation was employed to evaluate the programme theory, using focus group interviews and questionnaires. To gather additional evidence of the impact of Lesson Study on objective measures of teachers' questioning and children's learning outcomes, audio recordings, criterion referenced assessments and teacher/student interviews were used. According to Brender (2006), a triangulation of methods to investigate potential divergences within outcomes greatly increases the confidence in the findings and compensates for weaknesses in the methods otherwise applied. In the context of this study, triangulation served to compensate for lack of confidence or perceived weaknesses in the self-report data generated from the evaluation of the programme theory. While it was not feasible to apply such scientific objective measures to all levels of the programme theory, it was intended that by applying these measures and triangulating the data at

Levels 4 and 5, this would mitigate against criticisms to the validity of evidence generated, particularly given that these levels are considered the most difficult to evaluate (Guskey, 2002).

3.7 Overview of evaluation schedule

The evaluation of Lesson Study as a model of PD to supporting Irish primary teachers to enact the new primary mathematics curriculum was conducted over four phases. This schedule of evaluation included a preparatory phase and thereafter revolved around the Lesson Study intervention (pre-, during and post-). The following table details key actions taken, and milestones reached over the evaluation period.

Table 18. Overview of evaluation schedule

Research study preparation (December 2017 – February 2018) ✓ Ethics approval sought and granted from Research Ethics Board in Lincoln University ✓ Invitation issued to schools to participate in study ✓ Recruitment of the research sample ✓ Information and ethics form supplied to prospective participants ✓ School visit to meet with participants (and their principals) to explain nature and purpose of the study ✓ Provision of Information and Oral Ethics Briefing to participants. Signed consent from all participants [see Appendix 1] ✓ Individual teacher surveys completed (profile of teacher sample) [See Appendix 7]
Pre-Lesson Study intervention (February/March 2018) ✓ One day of PD sessions for teachers in (i) Lesson Study (aims, process and principles) and (ii) overview of the new primary mathematics curriculum (aims, rationale and specification) ✓ One day exploring theory-driven approach to evaluation and drafting, reviewing and redrafting the initial programme theory and logic model in collaboration with participants ✓ Skype meeting (Q&A) with Knowledgeable Other – An experienced academic in the field of early mathematics, located at Mary Immaculate College, Limerick ✓ Pre- and Post- Lesson Study criterion referenced assessment instruments designed ✓ Pre-Lesson Study audio recordings of teacher's maths lessons gathered

- ✓ Pre-Lesson Study assessments and teacher/student interview conducted with children (in-school by teachers)

Lesson Study intervention and evaluation (March – June 2018)

- ✓ Lesson Study teams in each school facilitated to engage in three cycles of Lesson Study

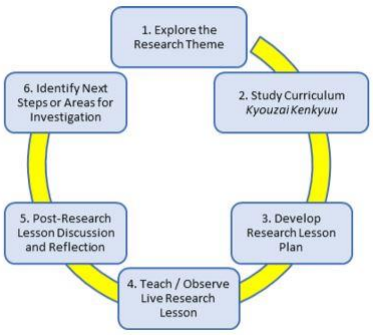

Figure 5. Lesson Study cycle employed in the evaluation study

- ✓ Plausibility checks conducted on the ToA and ToC
- ✓ Audio-recordings of Research Lessons gathered (each teacher in the Lesson Study team took it in turn to teach a Research Lesson)
- ✓ Evaluation of Levels 4 and 5 of the ToC (conducted after each Research Lesson)
- ✓ Lesson Study artefacts gathered following each cycle (Lesson plans, observation records, post-Lesson Study discussion notes and recordings)

Post-Lesson Study intervention (June 2018)

- ✓ Evaluation of Levels 1, 2, and 3 of the ToC and Lesson Study determinants/causal attribution
- ✓ Evaluation of ToA or test model of Lesson Study employed in the study
- ✓ Summative feedback gathered on the programme theory, Lesson Study intervention and participants experience with theory-driven evaluation process
- ✓ Post-Lesson Study audio recordings of teacher's maths lessons gathered
- ✓ Post-Lesson Study assessments and teacher/student interview conducted with children (in-school by teachers)
- ✓ Individual teacher testimonials completed and added to teacher survey data [See Appendix 7]

- ✓ A fourth audio recordings of each participants maths lesson was gathered 4 – 6 months post-Lesson Study. (Each participant was teaching a new cohort of children in a new academic year)

Chapter 4. Findings and Analysis

4.1 Strands of evaluation findings

The findings presented in this chapter represent the data collected over a nine-month period in 2018 (March to December) with nine participating teachers, across three Irish primary schools, as part of a theory-driven multi-site case study evaluation. The evaluation sought to investigate Lesson Study as a model of PD to support teachers to enact the new Irish primary mathematics curriculum. In simple terms, it sought to determine if it worked; and how and why it worked, from the perspective of participating teachers. In collecting the data, the researcher was mindful to gather evidence on measures that were meaningful to stakeholders of the evaluation (Guskey, 2002), namely primary teachers who will inevitably be tasked with enacting the curriculum, but also school leaders, policy makers, CPD providers and other researchers (particularly given the newness of the curriculum and the novelty of Lesson Study in Ireland). To increase the validity of this evidence and fortify the findings, multiple sources of data were collected (Guskey, 2012). The methods used to collect and handle the data are outlined in section 3.5.

Disentangling and elucidating the findings generated in the evaluation of an intervention such as Lesson Study, particularly in the context of curriculum enactment and change, and in school settings, is a complex process. To support the reader, the research findings are presented in strands, see figure 6 below. These strands hinge around the programme theory established by the teachers. The programme theory is comprised of a Theory of Change (ToC) which describes teachers' assumptions as to the anticipated outcomes and determinants of Lesson Study; and a Theory of Action (ToA) which makes explicit how Lesson Study works or is implemented in practice. The programme theory under investigation is outlined in greater detail in sub-section 3.4.1. The findings from testing and evaluating the ToC and ToA comprise the two key strands of the evaluation and are further substantiated by four additional sub-strands of evaluation findings.

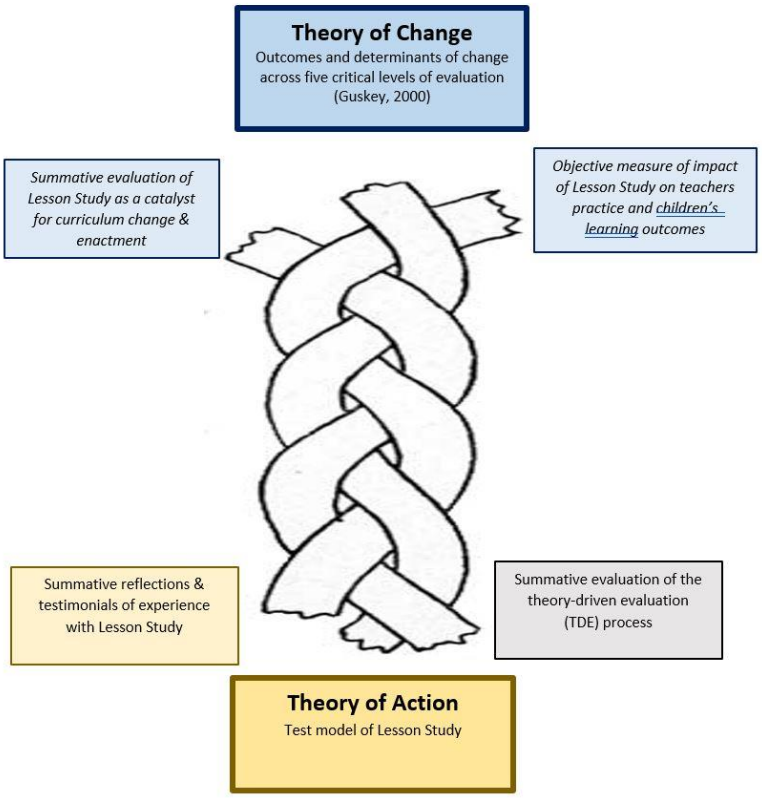

Figure 6. Strands of evaluation findings

4.1.1 Overview of evaluation findings

The following table provides an overview of the evaluation findings that will be presented in this chapter. For each strand and sub-strand of the evaluation findings, the specific aspect of evaluation, its purpose and the research question it primarily addresses are outlined. Moreover, the key methodological approaches adopted for each strand are also delineated. For ease of navigation, the corresponding chapter section for each strand of evaluation findings is highlighted in bold in the table also.

Table 19. Overview of evaluation findings

Strand of evaluation	Elements of evaluation	What is evaluated	Purpose of evaluation	RQ addressed	Method	Who	How collected	When	Output
Key strand 1 Evaluation of Theory of Change ToC **[Sub-section 4.2]**	Outcomes of Lesson Study intervention across five levels (teacher reactions; teacher learning; organisational support and change; teacher practice; children's learning outcomes)	Outcomes deemed necessary by teachers for enacting the new primary mathematics curriculum	To determine if Lesson Study produced the anticipated outcomes. To investigate unanticipated outcomes.	**Key RQ: Did it work (or not)? How did it work (or not)?**	Self-report (Levels 1-3) Self-report and researcher field notes (Levels 4-5)	Lesson Study (school) teams (n=3)	Focus group interviews	Levels 1-3 Post-Lesson Study Levels 4 and 5 Following each Lesson Study cycle	Refined Theory of Change *(What outcomes can be achieved by Lesson Study and what determinants contribute to this change)* **[Sub-section 4.2.6]**
	Causal attribution across five levels (teacher reactions; teacher learning; organisational support and change; teacher	The causal factors or intervening contextual variables which contributed to these outcomes	To determine what contributed to or caused these outcomes.	**Key RQ: Why did it work (or not)?**	Self-report	Full participant group (N=9)	Full group interview	Post-Lesson Study	

	practice; children's learning outcomes)								
Sub-strand 1A *Summative evaluation of Lesson Study as a catalyst for curriculum change and enactment* **[Sub-section 4.3]**	*Rating of Lesson Study as the catalyst for curriculum enactment*	*Teachers' views of Lesson Study in supporting them to enact the curriculum*	*Retrospective rating of Lesson Study (to confirm evaluation of PT)*	***Embedded RQ:*** *To what extent were the outcomes caused by Lesson Study?*	*Self-report*	*Lesson Study (schools) teams (n=3)*	Focus group interviews	Post-Lesson Study	
	Categorisation and rating of Lesson Study determinants across all five levels of evaluation	*Overall ratings of Lesson Study determinants (big picture)*	*To determine which Lesson Study determinants were most/least critical overall*	***Embedded RQ****: What aspects of Lesson Study were particularly important/ unimportant to the overall success of Lesson Study?*	*Self-report*	*Lesson Study (schools) teams (n=3)*	Focus group interviews	Post-Lesson Study	
Sub-strand 1B *Objective measure of impact of Lesson Study on teachers practice and children's learning outcomes*	Objective measure of teachers' use of new knowledge and skills (Level 4)	Teacher talk (questioning)	To determine if Lesson Study had an impact of the types of questions teachers pose in maths lessons *(given that supporting*	***Embedded RQ****: What impact did Lesson Study have on the types of questions that teachers pose in maths lessons?*	Self-record (researcher recorded the Research Lesson)	Individual teachers/researcher	Audio recording	1.Pre-Lesson Study 2.During Research Lessons 3.Post-Lesson Study (1 month) 4.Post-Lesson Study (4-6 months)	

[Sub-section 4.4]			*the development of children's adaptive reasoning was a core focus of Lesson Study)*	*(Level 4 outcome)*				
	Objective measure of children's learning outcomes (Level 5)	Children's understanding of Place Value	To determine if Lesson Study had an impact on children's performance on Place Value Assessment (Curriculum Learning Outcomes)	***Embedded RQ**: Did Lesson Study have an impact on children's understanding of Place Value? (Level 5 outcome)*	Pre/Post Assessment comparison	52 children across all three research sites (schools) [12]	Criterion-referenced assessment	1.Pre-Lesson Study 2.Post-Lesson Study
		Children's responses to open-ended questions	To determine if Lesson Study had an impact on children's reasoning skills	***Embedded RQ**: What impact did Lesson Study have on children's reasoning skills? (Level 5 outcome)*	Pre/Post comparison of responses	52 children across all three research sites (schools)	Teacher/Student interviews	1.Pre-Lesson Study 2.Post-Lesson Study

[12] Small school n=10; medium school n=24; large school n=18

Key strand 2 Evaluation of Theory of Action ToA **[Sub-section 4.5]**	Initial model of Lesson Study implementation	A test implementation model of Lesson Study	To critically assess the model of Lesson Study implemented in the study.	**Key RQ: In what conditions did it work? For whom?**	Self-report	Full participant group (N=9)	Group interview	Post-Lesson Study	Refined theory of action (How Lesson Study ought to work to best support the enactment of the new primary math curriculum) **[Section 4.5.3]**
Sub-strand 2A *Summative reflections and testimonials of experience with Lesson Study* **[Sub-section 4.6]**	*General reflections – 'in a word'*	*Feelings, thoughts and attitudes about the experience – pre/post Lesson Study*	*To determine if there had been a shift in their feelings, thoughts or attitudes?*	***Embedded RQ**: What was the collective experience of the participants group?*	*Self-report*	*Full participant group (N=9)*	*Group interview*	*Post-Lesson Study*	
	Individual testimonials	*Personal reflections on the experience; and most/least effective aspects*	*To expose potential outliers from group data*	***Embedded RQ:** What were the teacher's personal experiences of Lesson Study?*	*Self-report*	*Individual teachers*	*Questionnaire*	*Post-Lesson Study*	
Sub-strand 2B Summative evaluation of TDE process **[Sub-section 4.7]**	Summative evaluation of TDE process		To determine teachers' views and experience with the TDE evaluation process	What were participants' experiences of the evaluation process?	*Self-report*	*Full participant group* (N=9)	*Group interview*	*Post-Lesson Study*	

4.1.2 Quantifying participants' responses

To give some context to how the findings report on the teachers' commentary and in particular to give a sense of the level of consensus or disagreement in group responses or collective views shared by teachers, the following terms will be used to explain the quantity of responses from the participants.

Table 20. Quantifying participants' responses

Term	**No. of participants**
one	1
a couple	2
few or some	3-4
many	5-6
most	7-8
all	9

Where group responses were sought, participants were advised that if they disagreed with a view shared in the group, they should express this explicitly. Where disagreement was expressed, the quantity of agreement and disagreement is reflected in the reporting of responses. Where no disagreement was expressed, this was considered a unanimous response from all participants. Where relevant, distinctions between the quantity of responses from teachers across each of the schools are explicitly made.

4.2 Evaluation of Theory of Change

By testing and evaluating the ToC, the findings spoke to two research questions central to this study. (1) Does Lesson Study 'work' to support teachers to enact the curriculum? and (2) why does it work or what aspects of Lesson Study contribute to this, if any? Accordingly, findings derived from the evaluation of outcomes and determinants for each level of Guskey's (2000) framework of evaluation are presented in this section. Starting at level 1, the findings report the impact of Lesson Study on teachers' reactions. At level 2, the impact of Lesson Study on teachers' acquisition of new skills and practice is explored. At level 3, the impact on organisational change and support; at level 4, teachers' use of new skills and knowledge in their classroom practice; and finally, at level 5, the impact of Lesson Study on children's learning outcomes is outlined.

Importantly in terms of giving context to the findings, in the context of this study, the objective of Lesson Study was to support the enactment of the new primary mathematics curriculum. As such, two specific self-identified areas of the new curriculum were selected and isolated by the participants as a focus for Lesson Study activities, namely developing children's understanding of Place Value (Curriculum Learning Outcome Stage 1) and developing children's adaptive reasoning skills[13]. Evaluation findings at each level of the evaluation (Guskey, 2000) are contextualised in terms of Lesson Study's effectiveness in supporting teachers to enact these aspects of the new curriculum.

To evaluate outcomes at each level of Guskey's (2000) framework, teachers were asked to rate their actual experience against predefined success indicators [See sub-section 3.5.3 – Theory of Change outcomes across five levels]. Employing a six-point Likert scale (Rating key: 0= not at all, 1= little or no extent, 2= to a small extent, 3= to a moderate extent, 4= to a great extent, 5= to a very great extent), individual participant ratings were calculated to determine the average rating of the Lesson Study team. Ratings within the green zone indicate that the average response from participants was that these success indicators had been achieved to a great or very great extent. Ratings within the amber zone indicate some or moderate achievement of the indicators, while ratings in the red zone signify that success indicators were achieved to little or no extent. Evaluation ratings were further contextualised by explanations and examples provided by participants, and these qualitative findings are discussed in the subsequent sub-sections. For reference, the methods used to handle the data are outlined in sub-sections 3.5.3 and 3.5.4 and summarised in table 5.

In terms of exposing the process of change, the Lesson Study teams were initially asked to similarly rate each of the Lesson Study determinants according to a six-point Likert scale (Rating key: 0= not at all, 1= little or no extent, 2= to a small extent, 3= to a moderate extent, 4= to a great extent, 5= to a very great extent) according to the extent to which these determinants could be attributed to Lesson Study outcomes. However, as this approach generated a large volume of ratings and data which showed strong similarity across Lesson Study teams, it was therefore decided to also ask participants collectively, at the end of the evaluation, to categorise and rank Lesson Study determinants in terms of their contribution to outcomes at each of the respective levels. These later findings provided for more explanatory and illustrative data-set and are discussed with additional

[13]Adaptive reasoning is one of five aspects of mathematical proficiency, the development of which is the overarching aim of the new primary mathematics curriculum (NCCA, 2017).

contextualisation and distinctions provided by individual teacher reports. To gather a measured sense of causal attribution at each level, the study also explored alternative explanations for success and possible inhibitors to success; as well as asking participants to estimate the counterfactual situation. The methods used to handle this data are outlined in sub-section 3.5.4. Furthermore, the profile of participants and pseudonyms used to distinguish teachers within each of the Lesson Study teams is presented in table 3.

Commented [TC6]: Correction 5
Text and Table 14 in section 3.5.4 adjusted accordingly also

4.2.1 Outcomes at Level 1 (Teacher reactions)

The following figure 7 illustrates how each of the Lesson Study teams (schools) rated their actual experience of Lesson Study at level 1, specifically its impact on their reactions, against predefined success indicators [See sub-section 3.5.3 - Table 6].

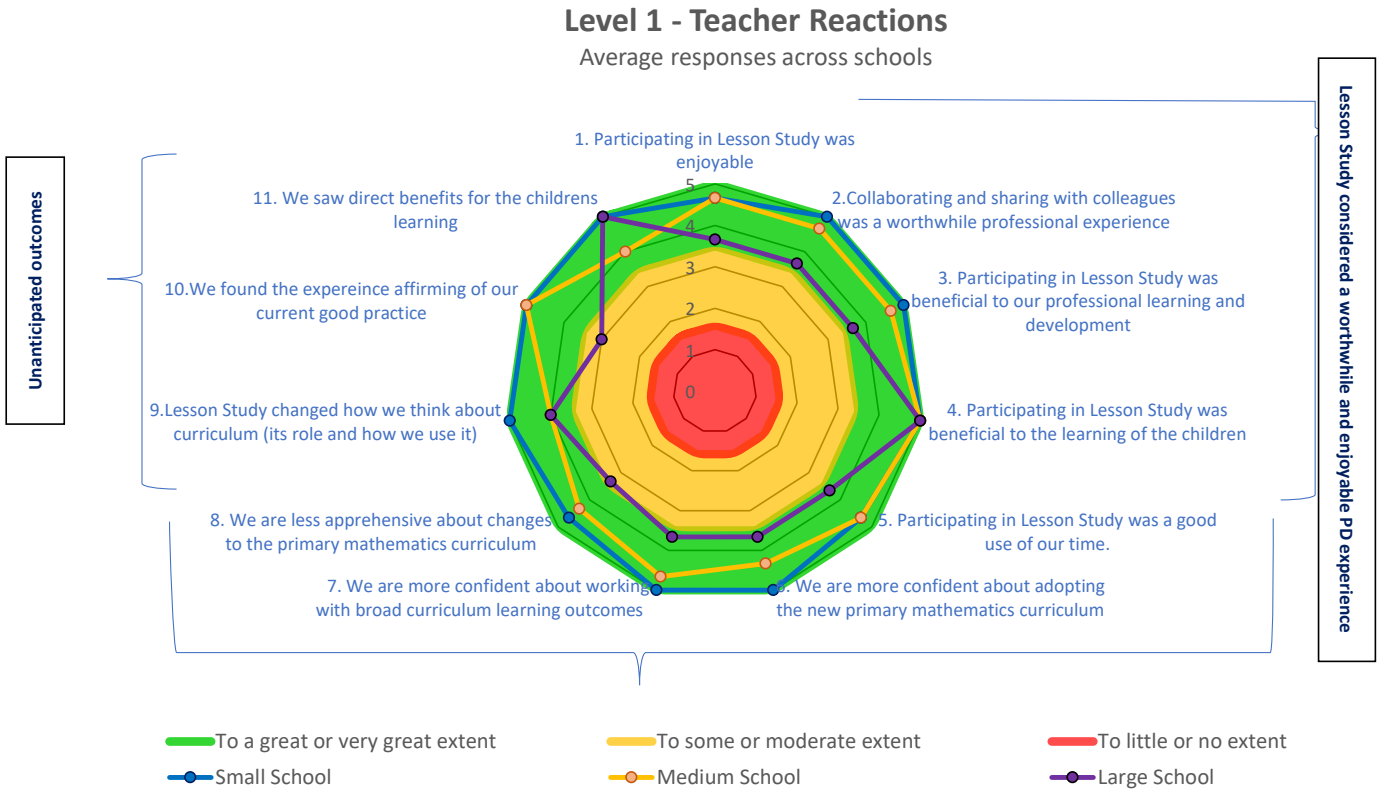

Figure 7. Achievement of success indicators at Level 1 – Teacher Reactions

Lesson Study considered a worthwhile and enjoyable PD experience

All teachers reported that Lesson Study was a worthwhile and enjoyable PD experience, particularly in terms of its perceived benefit to children's learning in their schools. Teachers in the small and medium school made reference to time as a key determining factor with Molly commenting "it was a fantastic use of our time" and Sonya similarly reporting, "it's a real good quality use of time". Sandra agreed with this sentiment but also expressed concern as to how this might work in practical terms across other schools. In contrast, while the teachers in the large school acknowledged that Lesson Study had been beneficial for their learning and the learning of their children, Lauren felt "it took a lot of time to achieve a very small goal for one topic and for one class". The teachers in the small school described the experience less in terms of how it supported them to enact smaller curriculum goals, but rather more so as supporting them to change their mindset. "Instead of three days of PD that you might or might not use, it was three days of changing our mindset" (Sonya).

Notwithstanding these commendations, Maria noted that Lesson Study had also been challenging, "there's a bit of work in it … and so much to think of". She specified that the post-Research Lesson discussions were the most challenging aspects of Lesson Study, where sometimes it could be difficult to be as honest and critical as one might like to be. Moreover, while Molly described Lesson Study as "manageable", this view was not shared by all of the teachers in the study, with a couple of teachers reporting that Lesson Study was "somewhat more work than anticipated" (Megan) and describing the full day with the facilitator as "full on" (Leah). For Leah and Lorraine, the most challenging aspect was teaching the lesson and "being watched" (Leah). For Lauren, dissatisfaction with Lesson Study stemmed from the constant changes made to the Research Lesson "every time we met to discuss the lesson it changed in some way, that was challenging". Leah offered the following explanation in response, "when you feel your idea is right and someone thinks their ideas were right, that is hard because everyone has their own way of teaching …. and sometimes we are set in our own ways of doing things". Lorraine surmised that for older teachers, this negotiation around the Research Lesson might be particularly difficult.

Despite the challenges involved, most participants described the overall experience of Lesson Study as enjoyable. The aspects of Lesson Study identified as being most enjoyable differed from teacher to teacher. For Sandra it was the trust that had been built up among her staff; for Selena it was learning from other teachers; for Megan it was "the change of scenery" and the opportunity to look at the dynamics of another class; for Maria it was

directly seeing the progress the children made during the period; while for Molly and Lauren it was the opportunity to observe the children in their own classes as someone else taught them.

More confident about the new curriculum and curriculum change

Many teachers reported feeling more equipped to adopt the changes presented in the new curriculum as a result of engaging in Lesson Study, a view unanimously expressed by teachers in the small school. Maria and Lauren identified the key challenge to enacting the new curriculum as the need to change teachers' mindsets about how children learn; and highlighted the importance of starting from the point of children's understanding and focusing on the acquisition and use of mathematical skills. Lauren described the new curriculum as placing a lot more emphasis on questioning and asking children to explain themselves, by posing questions such as "how did you get that? and why did you do or think that?"; commenting later in the evaluation that listening to children's explanations was very helpful to her own learning.

Most teachers expressed greater levels of positivity about the new curriculum as a result of engaging with Lesson Study. "I know what to expect and I feel reassured that it is very manageable, so I'm actually excited about the new curriculum" (Maria). In a similar way, Molly reported, "having got a better understanding of the children's level of understanding of Place Value, I feel way more confident about teaching this topic on [sic] the new curriculum". Molly's colleagues agreed that seeing the children progress and use appropriate language to convey their understanding of the topic (Place Value) was very encouraging.

Unanticipated outcomes

Following the intervention, participants noted three unanticipated outcomes at Level 1 which resulted from their participation in Lesson Study. Participants reported that (1) they found the experience of Lesson Study affirming of their good practice; (2) Lesson Study had changed how they think about curriculum, its role and how it is used, and (3) they saw direct benefits for the children's learning.

Molly shared that Lesson Study was affirming of the teaching and learning that was already taking place in her school, "it was more reassuring than anything because we do have what

it takes to teach this new curriculum". Sonya agreed, describing how the new curriculum was "bringing things back to basics" and challenged the teachers in her school to access their own intuitive knowledge of what works (in terms of children's learning) and put this into practice in the classroom.

There was agreement among all participants that Lesson Study challenged their thinking about curriculum, its role and how it is used, taught or enacted. Megan commented that "the curriculum gives us broad Learning Outcomes, but it doesn't tell us the learning objectives for our lessons or what we should teach. We had to just trust that the lesson goals [for the Research Lessons] we developed were the right approach to take". The teachers in the middle school were particularly welcoming of this change, noting a number of potential benefits to this approach. For Maria, "…with the current curriculum [DES, 1999] I think and compare my class with other classes, and if my children are not where another teacher's class is, I am thinking there is something wrong with me, rather than this is the class that I have", she later added, "a curriculum doesn't know where my class are at, I do". In a similar way, the teachers described how the Learning Outcomes approach in the new primary mathematics curriculum had offered them a sense of flexibility and agency in their teaching. Selena commented, "if it [the curriculum] is too specific, you don't even have to think, you could just pick up manuals that tell you what to teach day-by-day".

Molly shared how the experience of participating in Lesson Study has impacted her thinking as a professional.

> "If I'm being completely honest, when I came out of college, I never even thought I could make up my own learning goals, I wouldn't have trusted myself to do that, I would go straight to the book …. Since I left college, I have always felt that I am answerable to inspectors and questioning am I 'allowed' to do this or that, this [the new primary mathematics curriculum] definitely gives teachers more freedom" (Molly).

In contrasting their experiences of using the current curriculum and the new primary mathematics curriculum, Maria noted, "we did refer back to the [new] curriculum but only as a reference point, instead we looked at the broader Place Value concepts and developed our own ideas for the lessons". Similarly, Lauren reported, "we focused more on the children's learning as the starting point and allowed time to develop their ideas".

Causal attribution at Level 1

At the end of the intervention, participants agreed and categorised Lesson Study determinants according to the extent with which they could be attributed to the outcomes at Level 1; namely as most, least and not responsible for their reactions and level of satisfaction with Lesson Study. The three most critical determinants of success identified by the group were: (1) having opportunities to share and reflect with colleagues; (2) observing lessons in real time; and (3) directly seeing progress in children's learning. The categorisation and ranking of Lesson Study determinants at Level 1 is outlined in the following table. The three determinants identified by the participants as most critical are highlighted in bold.

Table 21. Categorisation and ranking of determinants at Level 1

Lesson Study determinants for outcomes at Level 1		
Most responsible	**Least responsible**	**Not responsible**
• Time and Space (to think about teaching and assessment ideas) (A) • ***Opportunities to share and reflect (B)*** • Working with Knowledgeable Other (C) • Investigating practice (E) • ***Observing lessons in real time (G)*** • Working collaboratively with colleagues (I) • Planning collaboratively (J) • Analysing and evaluating children's responses to teaching activities and instruction (M) • ***Directly seeing progress in children's learning (0)***	• Facilitated discussions (D) • Trying out new teaching ideas and strategies (F) • Having professional conversations around the Research Lesson (H) • Collective knowledge and expertise of peers (K) • Building on children's prior knowledge and misconceptions (L)	• Teacher Toolkit (Curriculum support materials) (N)

On consideration of other mediating factors which could be attributed to teachers' reactions and level of satisfaction with Lesson Study, participants offered a number of suggestions. For Molly, the opportunity to get out and meet other teachers and do something 'new' was enjoyable. Sandra described how the hot lunch provided at the group

meeting added to her enjoyment of the experience. Selena expressed that she felt she was partaking in something important and that excited her. Maria expressed that "it was nice to be treated like professionals, our views actually mattered, we are experts in our own learning, that's what it felt like". Maria also shared that she got great satisfaction knowing that the children in her class had really benefited in terms of her (professional) learning, adding that her participation "gave them [the children in her class] an advantage over other children in Senior Infants".

On exploration of possible inhibitors to Lesson Study achieving a greater level of success at Level 1, the teachers cited the time of the year and managing human resources as the main inhibitors. Lauren shared "even though we were happy with our experience and the meetings and the times we got together, asking our colleagues to cover classes wasn't always easy and we sometimes felt guilty for putting other teachers out". Maria added that organising substitute teachers can be problematic, particularly when not widely available, and consequently this meant an added layer of work. Finally, Megan felt that Term 3 of the school year (April – June) is not a suitable time for PD activities like Lesson Study because "there is so much to do at this time of year apart from PD".

On reflection and estimation of the counterfactual or what may have been the impact on teachers' reactions or levels of satisfaction, had they engaged with a more traditional model of PD (to support them to enact the new curriculum), some teachers described negative feelings to their experience with traditional PD, "I have never come out of those in-service meetings feeling anything but inadequate" (Sandra). Similarly, Molly described leaving traditional in-service curriculum events with an uncertain feeling of "what am I going to do now with the curriculum". In contrast, she felt that with Lesson Study she was not getting bogged down in new lingo, rather, "it's about bringing the classroom down to brass tacks in terms of what and how I am going to teach my next lesson". In comparing Lesson Study with traditional models of PD, Sonya described how traditional PD events typically involve someone else directing the conversation and "teachers being told what to do". In contrast, Maria noted that "during Lesson Study we are empowered to work at a professional level and decide what is best for ourselves as professionals". And Megan added "with Lesson Study, you are not told what to do, you are negotiating it [your PD] for yourself". Some teachers also highlighted the direct involvement of the children as a distinct feature of Lesson Study which positively differentiated it from traditional models of PD. On reflection of past experiences with PD, Lauren noted that children's learning or responses to different teaching approaches are rarely the focal point of discussions at PD

events. Maria and Sonya suggested that this is due to PD being designed for a generic audience and not being tailored to meet the needs of the school context.

4.2.2 Outcomes at Level 2 (Teachers' acquisition of new knowledge and skills)

The following figure 8 illustrates how each of the Lesson Study teams (schools) rated their actual experience of Lesson Study at level 2, specifically its impact on their learning and acquisition of new knowledge and skills [See sub-section 3.5.3 - Table 7].

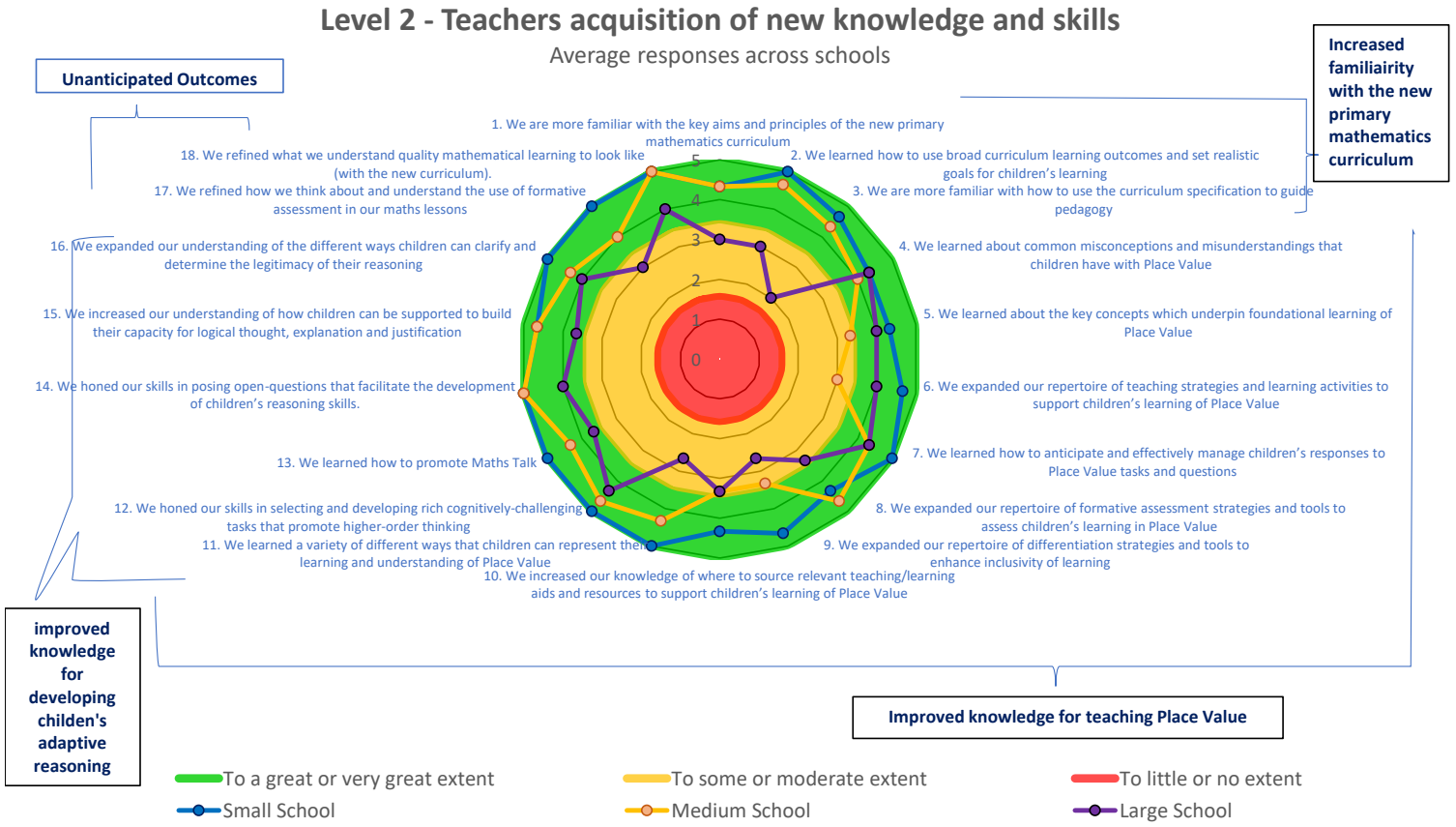

Figure 8. Achievement of success indicators at Level 2 – Teachers' Learning (Acquisition of new knowledge and skills)

Increased familiarity with the new primary mathematics curriculum

Looking at the overall findings in figure 8, the three schools differed slightly in terms of how they rated the impact of Lesson Study on their learning and acquisition of new skills and knowledge. In comparison with teachers in the large school, teachers in the medium school conveyed a sense of increased familiarity with the new curriculum, largely attributed to how they had engaged with it through Lesson Study. Molly noted "it's scary to see the curriculum at first, but actually working with it in the way that we did, I would be a lot more comfortable in knowing what to actually do with it in my own class". Teachers in the small school attributed much of their knowledge of the new curriculum to being provided with facilitated support and guidance, with Sandra commenting "I think it [Lesson Study] helped change our thinking about curriculum and how to use it".

In the large school, teachers reported that given how little they had used the actual curriculum document during the intervention, Lesson Study was not particularly important in helping them to become familiar with the curriculum. By way of explanation Lauren reported that given the broad nature of the Curriculum Learning Outcomes, "we used it [the curriculum] a lot at the beginning but not a whole lot after that". Leah remarked, "we translated [Curriculum] Learning Outcomes into goals for each of the [Research] lessons, based on what we understood them [the children] to already know". Leah added "we relied on our own experience and only went to the curriculum when we weren't sure".

Improved knowledge for teaching Place Value

As before, there were slight differences in how teachers reported the impact of Lesson Study in terms of their knowledge for teaching Place Value. Sandra expressed appreciation for how Lesson Study allowed for in-depth study of the topic, noting that "teachers have to make quick decisions, on the fly, every day, we don't often get the opportunity to think about why we teach a certain topic or why we might teach it in a particular way". Correspondingly, Lauren acknowledged the extent to which her increased knowledge for teaching Place Value had impacted on the quality and depth of questions she was now posing to the children. Sonya also noted how deepening her own knowledge helped her to identify some of the children's misconceptions about Place Value, "because I delved deeper, I could tell they had misunderstandings".

Teachers in the medium school expressed feeling knowledgeable about Place Value before commencing the intervention, however, Megan shared that the in-depth study she had engaged in during Lesson Study had whetted her appetite to learn more about the topic. She took upon herself the initiative to go online after the Lesson Study session [Kyouzai Kenkyuu] to research the origins of the base-ten numeration system and was observed to share this with the Lesson Study team at the next meeting.

Some teachers also remarked that they had a renewed appreciation for how central Place Value is to children's understanding of Number and learning across other domains of maths. "Before I would have started thinking they knew the importance of ten and how to group in tens but actually that's massive for building the foundations of the learning " (Molly).

Improved knowledge for developing children's adaptive reasoning

On reflection of their overall experience with Lesson Study, many of the participating teachers reflected that improvements in their knowledge for developing children's adaptive reasoning was the most significant outcome for them personally, "for me, that is where the greatest learning was" (Maria). On explaining what they had learned about developing and supporting children's adaptive reasoning skills, Sonya highlighted the importance of "posing good questions and waiting for them [the children] to respond". Similarly, Maria noted, "it's subtle things like waiting, asking a question in a slightly different way"; with her colleague Molly adding, "you can't just plough through maths (text)books and expect maths talk to improve, with this new curriculum it's about stopping and actually giving them a chance to talk and explain their thinking".

Lauren shared how participating in Lesson Study had adapted her teaching style to be more inclined to "step back, and let the children struggle with their learning". Furthermore, Sandra noted the importance of creating an environment "where it is ok to make a mistake", with Selena adding that mistakes identified in the lesson actually had a lot to offer the teachers in terms of their professional learning. Finally, Lauren commented that her experience with Lesson Study helped to broaden her awareness of different pedagogical approaches, "what one teacher will do and what another teacher would do, you get to see teaching in a ways that's different but equally as valuable as your own".

Unanticipated Outcomes

Following the intervention, participants noted two unanticipated outcomes at Level 2 which resulted from their participation in Lesson Study. Participants reported that (1) they refined how they think about and understand the use of formative assessment in their maths lessons, and (2) they refined what they understand mathematical learning to look like (with the new curriculum).

Across the three schools, participating teachers unanimously reported that an unanticipated but significant outcome from participating in Lesson Study was the identification of what Maria coined 'teachable moments' in their mathematics lessons. Teachable moments were defined as "getting an insight into what they (the children) do or don't understand" (Lauren), "something (they say or do that) you can use to build on what they know" (Selena), "when you can just tell that they are getting it or not" (Sandra). Maria and Sandra reported having a greater appreciation for how powerful teacher questioning can be to increase the proclivity for teachable moments to occur in their lessons. Molly reported having a greater appreciation for the opportunities for deeper learning that can occur when the lesson is not overly dominated by the teacher,

> "We learned the importance of pulling back and valuing time for talk, and thinking, and digging deeper with the children…. and being attentive to their talk… and this led to becoming more alert to teachable moments in lessons".

Correspondingly, Leah added to this, the importance of "allowing what needs to be taught to emerge from the children themselves".

Many of the participating teachers also commented on how participating in Lesson Study had altered their understanding of what good quality mathematical learning looks like (with the new curriculum). Maria and Molly noted in particular, the importance of simplicity, "we often don't realise [that] the more simple the lesson, the more rich it is for children" (Molly). "I learned how it only needs to be simple, we didn't have any fancy aspects to our lessons, it's the quality of the lesson that's most important" (Maria). By way of example, Molly noted how Lesson Study had changed how she now thinks about mathematical problem-solving, "it can just be a dilemma posed to the class, not a page of activities or word problems". Sandra reported a more significant shift in her thinking, "the basics of maths are not what I had previously thought them to be, the basic of maths is thinking and exploring, not doing pages of pointless activities in a textbook". Finally, a few teachers noted the importance of giving children time to engage in productive struggle, with

Lorraine remarking "I can see the value in the struggle and why I wouldn't just jump in to help them".

Causal Attribution at Level 2

At the end of the intervention, participants agreed and categorised Lesson Study determinants according to the extent with which they could be attributed to the outcomes at Level 2; namely as most, least and not responsible for their professional learning or acquisition of new knowledge and skills. The three most critical determinants of success identified by the group were (1) having time and space to think about teaching ideas, questioning techniques and ideas for formative assessment; (2) gaining the benefit of the collective knowledge and expertise of peers; and (3) analysing and evaluating children's response to teaching activities and instruction. The categorisation and ranking of these determinants at Level 2 is outlined in the following table. The three determinants identified by the participants as most critical are highlighted in bold.

Table 22. Categorisation and ranking of determinants at Level 2

Lesson Study determinants for outcomes at Level 2		
Most responsible	**Least responsible**	**Not responsible**
• **Time and Space (to think about teaching and assessment ideas) (A)** • Opportunities to share and reflect (B) • Investigating practice (E) • Trying out new teaching ideas and strategies (F) • Observing lessons in real time (G) • Having professional conversations around the Research Lesson (H) • ***Collective knowledge and expertise of peers (K)*** • Building on children's prior knowledge and misconceptions (L)	• Working with Knowledgeable Other (C) • Facilitated discussions (D) • Working collaboratively with colleagues (I) • Planning collaboratively (J) • Teacher Toolkit (Curriculum support materials) (N)	

• ***Analysing and evaluating children's responses to teaching activities and instruction (M)*** • Directly seeing progress in children's learning (0)		

On consideration of other mediating factors which could be attributed to teachers' learning of new knowledge and skills, aside from Lesson Study, Selena noted that she had completed a one-day course on the theme of 'Measures' , whilst Molly shared that she has completed a short 'Team-Teaching in Maths' course during the intervention period which may have impacted her learning.

On consideration of possible inhibitors to Lesson Study achieving a greater level of success at Level 2, many teachers agreed that the busyness of schools, particularly during the last term (Easter to summer) might impede the success of Lesson Study.

> "There's a lot going on in schools. You might like to give all your attention to teaching and learning but there are so many other things going on such as SSE, Child Protection, standardised testing, reports, and now we have GDPR to contend with" (Selena).

In response to this, Maria expressed, "if you don't get the time and space you need, it can definitely impact on your learning". In addition, Sonya cautioned against information overload when introducing a new curriculum, "you become saturated with information and then it becomes diluted". Finally, Lauren commented that before starting the study, she had heard negative reports about the curriculum which made her reluctant initially about using it, "word on the street about it (the curriculum), was that it was horrific and I was hesitant because of that".

On estimating the counterfactual or more specifically, what may have been the impact on teachers' learning or acquisition of new knowledge and skills, had they engaged with a more traditional model of PD (to support them to enact the new curriculum), many of the teachers responded strongly. Megan questioned the transferability of traditional PD, "it would give you information, and you would take notes, whether you would ever actually use them is another thing". Similarly, Molly questioned the sustainability of new knowledge and skills acquired with traditional PD, "I might learn it there and then (on the day) but later I would probably forget a lot of it". On reflection of the more valuable aspects of traditional PD for teachers learning, Molly noted that this "usually comes from talking with other

teachers, this may or may not happen on the day, it's not guaranteed". In comparing Lesson Study with traditional PD, Lauren commented

> "The valuable things we learned through Lesson Study were the teachable moments that came from actually trying out the curriculum, from teasing out different questions we could ask, and from actually listening to the children's responses. Traditional PD wouldn't afford us this experience. Lesson Study was more about us rethinking how [we] see teaching and learning maths in our classrooms".

4.2.3 Outcomes at Level 3 (Organisational change and support)

The following figure 9 illustrates how each of the Lesson Study teams (schools) rated their actual experience of Lesson Study at level 3, specifically its impact in terms of organisation change and support in their individual schools [See sub-section 3.5.3 - Table 8].

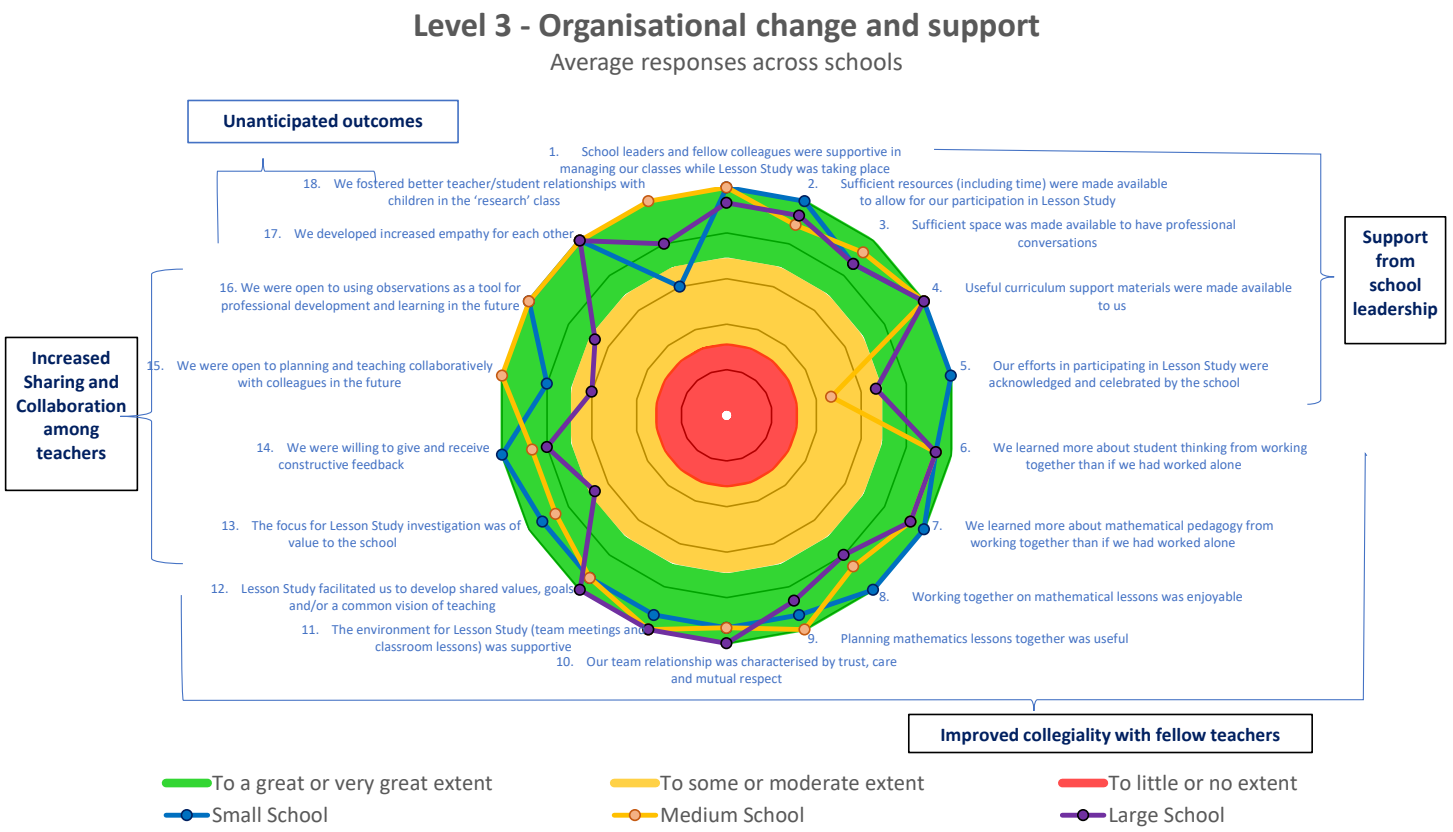

Figure 9. Achievement of success indicators at Level 3 – Organisational Support and Change

Most participating teachers reported that, overall, there was support from leadership to participate in Lesson Study and that the necessary space and resources were provided to them. In the small school, the teaching principal of the school was a member of the Lesson Study team and was, according to Selena, "very much open to it". Notably. teachers in the small school also reported having previous experience with observing each other teach with Droichead[14] and so observing in each other's classrooms was not new in the culture of the school.

Notwithstanding, there was a distinct difference across each of the cases in terms of how their participation was acknowledged and celebrated. In the large school, teachers described how logistical organisation of substitute teachers and cover for classes was the most challenging aspect for them. At the same time, they acknowledged the difficulty for the school principal to juggle these added organisational aspects with an already busy workload. Teachers in the middle school expressed the importance of ensuring all staff know what is happening and are involved so as to optimise their support, with Megan suggesting that a Croke Park[15] session with teachers may be useful to keep teachers informed.

Improved collegiality with fellow teachers

Across all cases, many teachers reported positively on the impact that Lesson Study had had on collegiality within their teams. Sandra and Megan both referenced how Lesson Study had helped to develop and foster mutual trust. Maria described how as Lesson Study sessions progressed, she felt less likely to compare herself to another teacher and/or think about being judged, whilst in a similar way Sandra noted "I don't think anyone felt they were being judged". Maria also described how having the opportunity to plan and teach with her colleagues gave her a better understanding of other teaching styles and approaches, and consequently became more comfortable working around each other. In contrast, teachers in the large school expressed how initially they were apprehensive about Lesson Study as they felt their teaching was "being watched" (Lorraine), and that it wasn't until after the third lesson before their sense of collective efficacy around the lesson was

[14] Droichead is a new model of teacher induction and probation for newly qualified teachers in Ireland (Teaching Council, 2016)
[15] Croke Park hours are mandated hours for schools to engage in collaborative planning and CPD, as outline in Croke Park Public Service Agreement, DES Circular, 0042/2016

established. One of the teachers in this school suggested that other mitigating factors at play in the school may also have impacted collegiality.

Sonya attributed the post Research Lesson discussion as playing a very strong role in improving the collegiality of the teachers in the small school, “there was a strong focus on this being ‘our lesson’ rather than scrutiny of someone else’s teaching”. Similarly, Maria expressed a sense of having shared ownership over the lesson, “I don’t think I would have been offended if you [the other teachers on the Lesson Study team] had been critical of the lesson I taught because it wasn’t just mine, if it [the lesson] failed it was because WE maybe missed something in our planning, or put in too much or too less”. Similarly, Sandra noted “I felt not on my own, we could go with the flow because we knew what each other was [sic] trying to do in terms of learning goals”. Megan too expressed “it was great to get feedback on the observations of other children’s learning”, adding that the post-Research Lesson discussions provided the Lesson Study team with a constructive space to have professional conversations and talk about teaching and learning. Lauren agreed that talking together and bouncing ideas off each other was useful. However, whilst acknowledging an increased sense of collegiality among the teachers involved in Lesson Study, Lauren was reluctant to suggest that any improvement in collegiality had extended beyond this core Lesson Study team to the wider staff.

Increased sharing and collaboration among teachers

All teachers said they enjoyed getting ideas from other teachers and noted the mutual benefit from this collective experience. For Selena this highlighted a salient point, “it just shows, it doesn’t matter what kind of teacher you are, different styles really work with them [children], they just love the playful engagement”. In a similar way, Maria also cited embracing more diversity in how teachers think and approach teaching. Sandra described a key strength of Lesson Study as “how we used each other as resources and can be each other’s best professional development”.

Maria expressed how following the study, she would feel more open to share and collaborate with her colleagues in the future. Megan surmised that the more frequently teachers might engage with Lesson Study, the more open they would likely become to sharing and collaboration. As found with other areas of positive change at this level, the post-Research Lesson discussions were credited with increasing teachers’ sense of sharing and collaboration. “Evaluating the lesson together was great because we could hear and

share *why* we thought aspects of the lesson worked or didn't work" (Maria). Meanwhile, Lauren describe how when the feedback was being shared, this helped her to reflect on alternative ways to asked questions in the lesson or introduce tasks.

Unanticipated Outcomes

In addition to increasing collegiality, sharing and collaboration, Sandra, a school principal, described how participating in Lesson Study had unexpectedly given her a deeper appreciation for the challenges that other teachers are faced with in her school. A couple of other teachers agreed that Lesson Study had also resulted in more empathy for their colleagues.

Another unanticipated outcome for some teachers at this level was how participating in Lesson Study, and in particular the Research Lesson, had developed a deeper affiliation with the children in the research class. Selena described the experiences of watching the children as a great way to get to know them, their strengths and, "you find that you are really so fond of them and their little ways". Furthermore, Maria described how letting other teachers in to watch her class showed her how "fiercely loyal" she is to the children in her class, and how she wanted them to show the observing teachers their "best side".

Causal Attribution at Level 3

At the end of the intervention, participants agreed and categorised Lesson Study determinants according to the extent with which they could be attributed to the outcomes at Level 3; namely as most, least and not responsible for organisational change and support at school level. The three most critical determinants of success identified by the group were; (1) having opportunities to share and reflect with colleagues; (2) having professional conversations around the Research Lesson; and (3) working collaboratively with colleagues. The categorisation and ranking of Lesson Study determinants at Level 3 is outlined in the following table. The three determinants identified by the participants as most critical are highlighted in bold.

Table 23. Categorisation and ranking of determinants at Level 3

Lesson Study determinants for outcomes at Level 3		
Most responsible	**Least responsible**	**Not responsible**

• Time and Space (to think about teaching and assessment ideas) (A) • ***Opportunities to share and reflect (B)*** • Facilitated discussions (D) • Observing lessons in real time (G) • ***Having professional conversations* around the Research Lesson (H)** • ***Working collaboratively with colleagues (I)*** • Planning collaboratively (J) • Collective knowledge and expertise of peers (K)	• Working with Knowledgeable Other (C) • Investigating practice (E) • Trying out new teaching ideas and strategies (F) • Building on children's prior knowledge and misconceptions (L) • Analysing and evaluating children's responses to teaching activities and instruction (M) • Directly seeing children's progress (0)	• Teacher Toolkit (Curriculum support materials) (N)

On consideration of other mediating factors which could be attributed to organisational support and change, the teachers suggested a number of alternative explanations. Molly noted that the participants in the study were a very open group of teachers given that they volunteered to participate in the study in the first place. As such, the personalities of the sample group members likely impacted the outcomes reported at level 3. Moreover, teachers in the medium and large school noted two events which may also have contributed to teachers' collegiality and sense of sharing and collaboration in their schools during the intervention period. Lauren described how when she was out of school for a short period, Leah had stepped in to help manage her class. And Maria noted that Literacy Lift-Off (an early literacy intervention programme) had commenced in the medium school during the time period that Lesson Study had taken place which also required teachers to plan and work collaboratively.

On examination of possible inhibitors to Lesson Study achieving a greater level of success at Level 3, the teachers cited school culture and time factors. According to Leah, "school culture and particularly support from higher up (senior school leadership) is the trickiest part". Lauren added that being a small group [Lesson Study team], working in isolation of the larger school group meant that many of the other staff did not know what they were doing, and this contributed a sense of feeling like a hindrance when asking other teachers to help with organising classes or substitute cover. Lauren and Molly both described how

other teachers in their schools held misconceptions about what the Lesson Study group was doing which may have inhibited them from supporting their colleagues. In hindsight, the Lesson Study team in the large school reported that it would have benefitted them if some time had been dedicated to explaining to the wider staff, what was involved in Lesson Study. Furthermore, some teachers deemed the final school term as the least suitable time for schools "there is a lot going on in schools during the last term" (Selena) and as such the timing of an intervention may also contribute to it being considered a hindrance in schools.

Finally, teachers were asked to reflect on and estimate the counterfactual or what may have been the impact on Level 3, if teachers had experienced a more traditional model of PD. Leah commented that traditional in-service wouldn't have been concerned with organisational change and support, so even if it provided information about the curriculum as a document, teachers would unlikely be any more equipped to help each other out at school level with it. To illustrate, Molly surmised that following traditional PD or curriculum in-service, the teachers in her schools would likely come together to talk about how to navigate the curriculum document and discuss what they perceived the 'inspector' would want to see in terms of planning, but that they would be less likely to talk about how to use it or teach it. Similarly, Maria commented that conversations would likely centre on resources and equipment that the curriculum says is needed, rather than on about actual pedagogy or sharing ideas for using the new curriculum. Teachers in the small school noted that, unlike Lesson Study, traditional in-service is not typically sustained, and that "one day of in-service looking at a PowerPoint would not be enough" (Selena). In summing up her comparison between Lesson Study and traditional CPD, Sonya commented "it's how it [Lesson Study] changes your mindset that makes the biggest difference as to whether you're going to pick up the curriculum and run with it or not".

4.2.4 Outcomes at Level 4 (Teachers' use of skills and knowledge in practice)

Figure 9 below shows how participants in each of the Lesson Study teams collectively rated teachers use of new knowledge and skills from observations of the Research Lessons, against predefined success indicators for level 4 [See sub-section 3.5.3 - Table 9]. Quantitative findings at this level were further contextualised by explanations and examples provided by participants. Given the challenges and limitations of measuring teachers self-reporting of classroom practice (Reddy et al., 2015), the findings also incorporate field notes taken by the researcher during live Research Lessons. Qualitative

findings describe change and progression in terms of teachers practice as Lesson Study advanced and are discussed in the subsequent sections.

It should be noted that teachers' identification of teachable moments is not featured explicitly in the list of outcomes and success indicators for Level 4 [See sub-section 3.5.3 - Table 9], nor was it explicitly spotlighted as an unanticipated outcome and as such, rated by the participants as part of the evaluation. Notwithstanding, given the prominence and recurring reference made to 'teachable moments' in the raw data findings and analysis of observation records, fields notes and transcripts of teacher feedback and commentary; the identification of teachable moments was elevated by the researcher as an addition outcome of significance at Level 4.

To triangulate these self-report findings at Level 4, the researcher elected to isolate the third anticipated outcome at Level 4, namely 'the development of children's adaptive reasoning skills'; and further the impact of Lesson Study on teacher questioning using objective measures (i.e. non-self-report). Specifically, measures were taken of teachers' question types and the frequency and proportional use of open-ended questions posed in maths lessons at four different intervals of the study. This investigation took place concomitant to the ToC evaluation and the findings from this investigation are outlined in section 4.4.

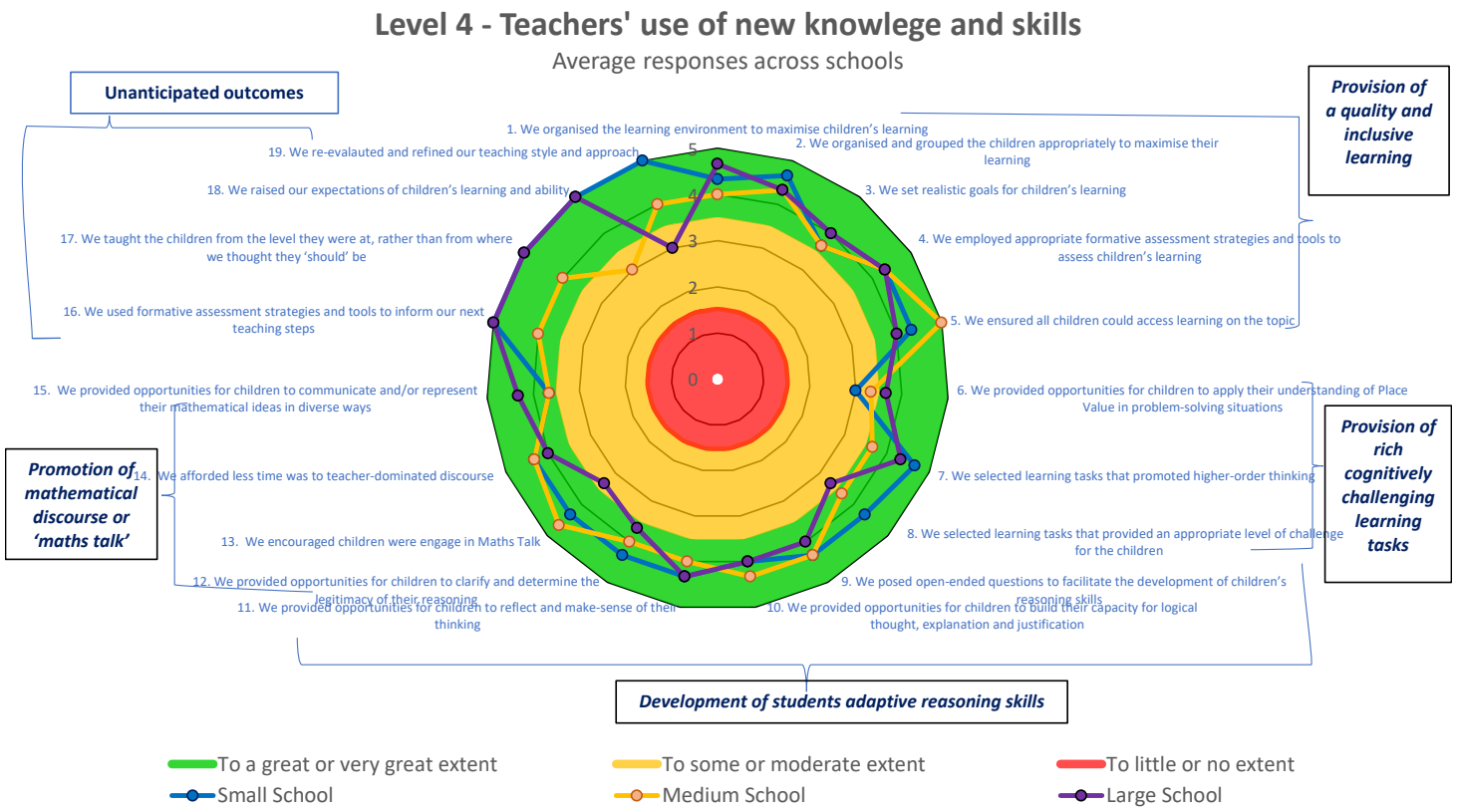

Figure 10. Achievement of success indicators at Level 4 – Teacher Practice (Use of new knowledge and skills)

Provision of quality and inclusive learning environment

A few teachers reported initial difficulties with time management and setting realistic goals for children's learning, this was foreseeable given that Place Value is a new curriculum topic to teach children at Senior Infants level. Many teachers reported that they found observation of the children's learning very useful in helping them set more realistic goals in their lessons and that they found themselves "listening very intently to what the children were saying" (Megan). Accordingly, the researcher observed that over the course of the three Lesson Study cycles, the teachers fine-tuned their lessons in response to assessment and observation data they had collected in the preceding Research Lesson. Moreover, this assessment and observation data of children's understanding (or lack of understanding), was the focal point of discussion when devising learning goals and making pedagogical decisions for future lessons.

Despite initially reporting that they had allowed inadequate waiting time or dedicated time for children to respond to their questions, the researcher observed the teachers in the small and medium schools give increasing weight to the importance of wait time and were observed to steadily increase the amount of time they allowed for the children to process their learning, as each Lesson Study cycle took place. In the large school, Lauren commented on the value of designing "shorter sharper lessons that are concentrated but gave the children a better opportunity to really think about and understand what they were doing". Similarly, Maria noted the importance of reducing content in future lessons to "allow children to talk and think about their ideas and solutions to problems". With each Lesson Study cycle, all teachers were observed by the researcher to demonstrate greater ease in adapting their teaching mid-lesson, in response to unexpected ideas and responses shared by the children.

Across all schools, the teachers were observed to use questioning increasingly more effectively as a tool for assessing and differentiating children's learning in the research class. Similarly, the teachers were observed to spend considerably more time crafting (a wide range of) questions in the planning phase of each subsequent Lesson Study cycle which would challenge the children at an appropriate level, including targeting less and more able children. Many reported that in posing a wider range of questions to the children, they had provided for a greater level of inclusion in their lessons. Consequently, these teachers reported developing a renewed appreciation of and proclivity for using

observation as a tool for assessing children's understanding and using questioning to promote inclusion in their classrooms.

Provision of rich cognitively challenging tasks

Participants evaluated their provision of rich cognitively challenging tasks positively. In describing how they made the learning tasks more challenging, the teachers, in the small school, noted that posing an appropriate dilemma for the children to solve, and asking differentiated questions, ensured the right level of challenge. The researcher noted in particular how the teachers in this school increasingly used questioning to good effect in targeting individual children at an appropriate level of challenge. On reflection of the final Research Lesson, Maria commented "we didn't put a cap on what they [the children] could do so they were exploring and expanding their thinking beyond what we might have initially thought".

A common response from teachers in all schools following the first Research Lesson was how surprised they were at how well the children managed and responded to the level of challenge posed to them in the lesson. "I think there was a lot in it [the lesson] but it was a good challenge for them" (Sonya); "they were definitely stretched but they were well able for it" (Megan). Despite increasing the level of challenge further again in the second and final Research Lesson, many teachers continued to remark about how their expectations of the children had been raised as a result of seeing how well they rose to the challenge. Selena commented on how pleasantly surprised she was with the performance of one particular child who would not typically stand out from her peers. She added that it was very fulfilling for the child to get recognition for this, "… did you see Child X? she was delighted with herself". Tellingly, when asked to note any unanticipated outcomes for their practice at Level 4, most teachers reported having raised their expectations of learners (discussed below). Many teachers also expressed enthusiasm to continue to stretch the children beyond the Lesson Study space based on their experiences of observing the children and their ability to meet the challenges posed in the Research Lessons.

In addition to discovering new insights into the children's abilities, many teachers also reported that observations of children participating in tasks offered important insights as to what they did not know. "They were definitely challenged but I think finding out what they didn't know was really useful for our own [professional] learning" (Sandra). In terms of the teachers use of tasks in the Research Lessons, the researcher observed that, as the Lesson

Study cycles progressed, many teachers became increasingly critical of the tasks which they had devised for the Research Lessons. In planning sessions for the final Research Lesson, teachers in the small and large schools discussed how they could make learning tasks more engaging by building on prior knowledge and incorporating different real-life situations. On reflection of the learning task provided in Research Lesson 3, Leah reported that "the tasks devised for the lesson were far more appropriate because we really thought about the task and we were able to incorporate what we knew about their prior knowledge".

Development of children's adaptive reasoning

Upon evaluating the first Research Lesson, a common critique from each of the Lesson Study teams was the lack of time allocated in the lesson to allow children to explain and justify their thinking. Following this first Lesson Study cycle, the teachers reported recognising that additional waiting time and opportunities for the children to legitimise their thinking and ideas would support the development of their adaptive reasoning. Parenthetically, Molly remarked that traditional maths lessons which involve textbooks present somewhat of a barrier for developing children's thinking and adaptive reasoning skills, "for getting them [the children] thinking, they aren't the best". Molly further commented "I would have preferred to ask more high-order questions, we could have made it a lot trickier but I think that might be a good idea for the task the next day, even repeating what we already did but expanding on it". In the second Research Lesson, the researcher observed teachers in each of the respective Lesson Study teams focus their planning and teaching on using open-ended questions to elicit, support and extend children's thinking. When additional time was allocated to allow the children to think and explain, Sandra reported that some of the children were "visibly struggling".

Following the first Lesson Study cycle, the researcher noted that the style of questioning posed to children was a considerable focal point of discussion among each of the Lesson Study teams, and an aspect of their teaching practice which the teachers continued to give time and attention to, and which they were observed to subsequently refine over the intervention period. In conversation, Lorraine reflected, "it's powerful to make an example of the wrong answer and to give them a chance to interrogate why it's not right"; to which Lauren responded, "if we had never put time or emphasis on the wrong answer, they wouldn't have had the benefit of seeing why it was wrong". Over the period, teachers reported that certain open questions yielded more meaningful and insightful results than

others, such as “Is that fair?” (Lauren), “does that look right?” (Molly), “how do you know?” (Sonya). On summation, Lauren reported that with each Research Lesson she became more careful about “wording the question so it would generate the right kind of thinking”.

Promotion of mathematical discourse or ‘maths talk’

Low propensity to engage in maths talk was reported from observations of children in the first Research Lessons in each of the schools. Sandra noted that the lack of maths talk in the first Research Lesson could possibly have been attributed to the introductory nature of the lesson, the use of new vocabulary and having to demonstrate and model aspects of the lesson. She added “it’s not a strength of theirs as they like working on their own, 6-year-olds tend to be ego-centric”. Lorraine reported that in her school “there was more teacher/child interaction than the children interacting together”, again this was attributed to the prevalence of teacher demonstration. From this reflection, the teachers determined to take a step back and allow for greater maths talk and peer interaction. Accordingly, the researcher observed the teachers taking a more passive role in each of the second Research Lessons. On reflection of this lesson, Lorraine commented, “yes, there were lots of time that we could have said more but we did step back and allow them to figure it out for themselves”. There was also a lot more chat and interaction in the medium school. Maria reported, “they were constantly discussing ideas, especially when we set them the task”.

In the small and large school, the researcher observed a noticeable increase in the explicit allocation of time for maths talk in the final Research Lessons conducted. Following this lesson, Sandra reflected, “they [the children] were talking all the way through the lesson, both with us and together”. Leah described how the teachers in their Lesson Study team “made a real effort to hold back on telling them what to do” and this yielded more perceptive discussions, which gave an insight into the children’s level of understanding. Moreover, Lauren reported that the children were now using more appropriate language to talk about their ideas and used materials appropriately to represent their ideas as well.

Finally, the teachers reported that they had refined the strategies they used to elicit maths talk in the classroom. In the small school the teachers reported intentionally using barrier games, whereas in the medium and large school the teachers reported using think/pair/share co-operative learning strategies to promote greater levels of discourse among the children.

Unanticipated Outcomes

Following the intervention, participants noted four unanticipated outcomes at Level 4 which resulted from their participation in Lesson Study. Participants reported that in addition to the aforementioned indicators, they also (1) used formative assessment strategies and tools to inform their next teaching steps; (2) taught children from the level they were 'at' rather than from where they thought they 'should be'; (3) raised their expectations of children's learning and ability; and (4) re-evaluated and refined their teaching style and approach.

In describing how the teachers had used formative assessment strategies and tools to inform their next teaching steps, Lorraine reflected post Research Lesson 2, "I found I gave more attention to their answers and figuring out the logic behind, and where they were going wrong". Similarly, post Research Lesson 3, Maria reflected, "we were more alert to the possibilities of what learning should come next, and when we finished our lessons we connected and thought about which direction we could go on for the next lesson". As examples of how they used formative assessment in a different way in their classrooms, many teachers described how they asked open-ended questions; and were attentive to maths talk and teachable moments which helped them to determine children's understandings, misunderstandings and misconceptions about the topic of learning. "The questioning let us know where they were" (Sandra). During post-Research Lesson discussions, many teachers noted the authentic nature of this approach to assessment, as they took the learning gleaned from teachable moments in the lesson and used them to inform the future direction of the lesson or future Research Lessons. Correspondingly, the researcher observed how data gathered from classroom assessment and observations of the lesson fed directly into planning and teaching Research Lessons.

In terms of how teachers pitched their teaching in the Research Lessons, most teachers reported that they found themselves, as Lorraine phrased "teaching the children from the level they were at, rather than from where we thought they should be". For Sonya, Lesson Study honed her sense of "where the children are at" in their class. On assessing the children's learning in a formative way, Leah reported "I was asking myself, what is the child trying to say?, I found myself really listening to them; and when they gave an answer, I was thinking, where would she get that from?". In practical terms, Maria commented how this approach meant that the lessons flowed from one to the other because they were guided

by where the children were at, a key outcome of the intervention also observed by the researcher.

Some teachers in the small and medium school reported that another key outcome from their participation in Lesson Study was raised expectations of children's learning and ability, with Sonya describing how engaged the children were with such a difficult and new topic (Place Value) as "incredible" and Molly describing the progress of the children in her school as "impressive". In particular, the three teachers in the small school, where junior infant children were also involved in the Research Lesson, remarked on how surprised they were at the progress that these younger children (typically aged 4-5 years) also made in their learning during the intervention period. Consequently, Selena and Sonya reported that they had adjusted their teaching in response to these raised expectations, both in and out of the Lesson Study space. In the medium school, Maria described how her experience with Lesson Study had raised her expectations of the children in her class and had fostered a renewed appreciation for her own professional judgement and evaluation of the children's learning, based on her observations of children's learning.

A final outcome that many teachers had not anticipated in their practice from the outset, was how they would re-evaluate their teaching style and approach as a result of participating in Lesson Study. Megan reported that Lesson Study had changed her mindset around teaching mathematics.

> *"I think before I asked questions to get the right answer, whereas now I ask questions to get them thinking and to see if they understanding the ideas underpinning what we are talking about. I'm giving them time to justify their answers and that sort of thing".*

Sonya agreed with this point, adding that her focus had shifted to investigating children's level of understanding and /or where children may be having misunderstandings or misconceptions around a mathematical idea. In a similar way, Maria reported allowing the children to take control of the lesson and finding herself pulling back from didactic instruction. For Megan, participating in Lesson Study resulted in her giving the children "more opportunities to talk and really listening to the responses". Lorraine reported allowing more wait time when teaching, "it was a big change to stop myself jumping in", with Leah adding "I did have a tendency before [pre-Lesson Study] to give them the answer, I think I changed my style of questions, I used to ask leading questions". On a practical level, Lauren noted that, following Lesson Study, she finds herself now spending more time

concentrating on the children's intended learning than on her actual written plan. Meanwhile, Maria reflected "I was surprised how much we were able to do with the lessons without a textbook". Finally Megan reported that her participation in Lesson Study had caused her to reassess her role as teacher – "you hear the word facilitator all the time but I really feel like I am taking on that role now and properly doing it; and I see the value of stepping back".

Identification of 'teachable moments'

Although not spotlighted and rated explicitly by the participants during the evaluation, an additional outcome emerged strongly from analysis of the qualitative data gathered. Across all school, teachers reported how in a variety of ways, they had identified moments of unexpected insight within the Research Lessons, which they then subsequently used to adjust their teaching in the lesson; and also to inform their planning and mobilise their actions in successive Research Lessons. On consideration of the descriptions which teachers provided to describe these moments or periods of insight, the researcher coined the term 'teachable moments' which participants referred to explicitly thereafter when reporting on their experiences. This outcome was largely deduced from the explanations provided by teachers for success at Level 5. Moreover, the researcher observed an increasingly level ofresponsiveness to children in the Research Lessons; and an increasing level of astuteness and perceptiveness among the teachers during post-Research Lesson discussions when discussing and analysing children's understandings, misunderstandings and misconceptions. The Lesson Study teams were also observed to use this analysis as the impetus for future planning and to support them to devise new learning targets (for subsequent Research Lessons).

For these reasons, the 'identification of teachable moments' was deemed worthy of promotion to outcome status by the researcher given the prevalent and consistent way in which it was observed by the researcher and cited (implicitly and explicitly) in teachers reporting and feedback across all schools. The teachers gave numerous examples, of which the following serve to illustrate. Following the first Research Lesson, Maria and Molly remarked that the structure of the Research Lesson encouraged the teachers to "look for moments that would give us more insight into what they knew and didn't know" and "knowing this now we can work on those areas [that they found challenging] in the next lesson". Similarly, Sandra reported that they [Small school Lesson Study team] were keenly

focused and “picked up on different things” that the children understood or misconceptions they held during the lesson. Following the first Research Lesson in the large school, Leah reported that “the observations were fantastic for being able to see what they actually know and where they are getting stuck”. In cycle 2, Molly commented on how much could be gleaned from observing the children’s learning that could feed into future lessons “when we really looked at the children’s learning, we found so many teachable moments, there were so many different things we could have focused on following the observation”. On deliberation of the role of Lesson Study in supporting them to enact the curriculum, Molly reported “when they [the Research Lessons] were over we were able to sit down and talk to each other about how we could go about building on what they know or help them with the aspects that they are falling down on”.

On reflection of children’s learning over the intervention period, teachers in the three schools consistently commented on how the teaching was targeted at the children’s individual level in a way that the teachers had previously found challenging to accomplish in a busy classroom context. For this, much credit was afforded to the identification of these ‘teachable moments’, with Maria reporting

> *“the teachable moments were powerful because when we went back to the child, we were going from exactly where we knew they were at. It’s the children’s prior knowledge or needs that you are facilitating… not your notes [Lesson plans] …. it’s a different way of planning, teaching and assessing children’s learning”.*

This view was echoed strongly in the large school also where Lorraine described how identifying these moments in the lesson was “bringing their learning onto another level”.

Such was the significance of the teachable moments identified in the lessons that the researcher observed that following the first Research Lesson, none of the teachers were found to revert to the curriculum specification to advise them on learning targets for Research Lessons 2 or 3. When the curriculum document was used, this was predominantly for reference purposes. Confirmatively, Lauren concluded, “with the exception of the first lesson, our goals for every subsequent lesson came from our observations of the children’s learning in the lesson before. We used all of this information to inform the next lesson”. Put simply, beyond the initial planning stage, the teachers were found to rely on the curriculum to tell them what to teach, rather they took their cues and prompts from what they understood the children to know or not know.

Causal Attribution at Level 4

At the end of the intervention, participants agreed and categorised Lesson Study determinants according to the extent with which they could be attributed to the outcomes at Level 4; namely as most, least and not responsible for organisational change and support at school level. The three most critical determinants of success identified by the group were; (1) having time and space to think about teaching and assessment ideas; (2) having professional conversations around the Research Lesson; and (3) analysing and evaluating children's responses to teaching activities and instruction. The categorisation and ranking of Lesson Study determinants at Level 4 is outlined in the following table. The three determinants identified by the participants as most critical are highlighted in bold.

Table 24. Categorisation and ranking of determinants at Level 4

Lesson Study determinants for outcomes at Level 4		
Most responsible for outcomes	**Least responsible for outcomes**	**Not responsible**
• ***Time and Space (to think about teaching and assessment ideas**) (A) • Opportunities to share and reflect (B) • Facilitated Discussions (D) • Investigating practice (E) • Trying out new teaching ideas and strategies (F) • Observing Lessons in Real Time (G) • ***Having professional conversations around the Research Lesson (H)** • Working Collaboratively with colleagues (I) • Planning Collaboratively (J) • Collective knowledge and expertise of peers (K) • Building on children's prior knowledge and misconceptions (L) • ***Analysing and evaluating children's responses to teaching activities and instruction (M)**	• Working with Knowledgeable Other (C) • Teacher Toolkit (Curriculum support materials) (N)	

• Directly seeing children's progress (N)		

On consideration of other mediating factors which could be attributed to outcomes at Level 4, in terms of their use of new skills and knowledge in practice, aside from Lesson Study. Lauren described how she had conducted some reading around Mata sa Rang[16] and this may have impacted how she taught or approached the teaching of number during the period. Furthermore, Sandra expressed how participating in team teaching in the infant classroom for Aistear[17] that year had likely had an impact on her practice also.

The participants did not offer suggestions about possible inhibitors to Lesson Study achieving a greater level of success at Level 4 in their respective cases. Rather they concluded that a lack of (teacher) understanding of children's level of language and reasoning skills, or more specifically as suggested by Megan, "a lack of familiarity and confidence with the types of questions to ask or that need to be asked to develop children's reasoning skills" may pose a possible inhibitor to improving practice. All teachers expressed that in this case, the Knowledgeable Other or facilitator has an important role to support teachers.

On comparing and contrasting Lesson Study with traditional PD, Lauren referenced the most recent curriculum in-service provided to primary teachers[18] *"*Given what [PD] we got for the last new curriculum, I don't think it would have necessarily influenced or impacted our practice at all*"*. Maria added that in her experience, curriculum in-service typically focuses on content areas/strands or topics of learning, more so than on the actual teaching [or enactment] of the curriculum. On reflection of the kind of CPD that Lauren believes is needed to support teachers to enact the new primary curriculum, she noted that *"*less focus should be on mathematical content but more on skills and how you teach those skills. These are the biggest changes as far as I can see*"*. Molly offered the following analogy as a means of illustrating the key differences between traditional CPD and Lesson Study, which provides a useful synopsis of the views that emerged from the group. *"*The typical CPD we

[16] Mata sa Rang is Irish early maths intervention programme based on the tenets of Maths Recovery – see www.mata.ie
[17] Aistear is a curriculum framework for Irish children aged 3-6 years with a strong emphasis on playful pedagogies.
[18] This curriculum in-service took place about 4 months prior to the commencement of the Lesson Study intervention and also focused on introducing new curriculum reforms, albeit for language in this incidence.

are used to is like giving us [teachers] fish while Lesson Study teaches us how to fish so we can do it for ourselves" (Molly).

4.2.5 Outcomes at Level 5 (Children's learning outcomes)

The following figure 11 shows how participants in each of the Lesson Study teams rated their actual experience against predefined Level 5 success indicators. As with level 4, evaluation findings were further contextualised by explanations and examples provided by participants and by field notes taken by the researcher during observations of Research Lessons. These qualitative findings are discussed in the subsequent sections.

Furthermore, as before, to triangulate the findings at Level 5, the two outcomes at Level 5 were subjected to further investigation and evaluation by the researcher concurrent to the ToC evaluation, using objective measures (non-self-report). Specifically, measures were taken of children's understanding of Place Value, the quality of the reasoning skills and the types of responses given to open-ended questions posed by teachers. These measures were taken at two intervals of the study: pre- and post-Lesson Study. In section 4.4, the findings from this investigation are presented.

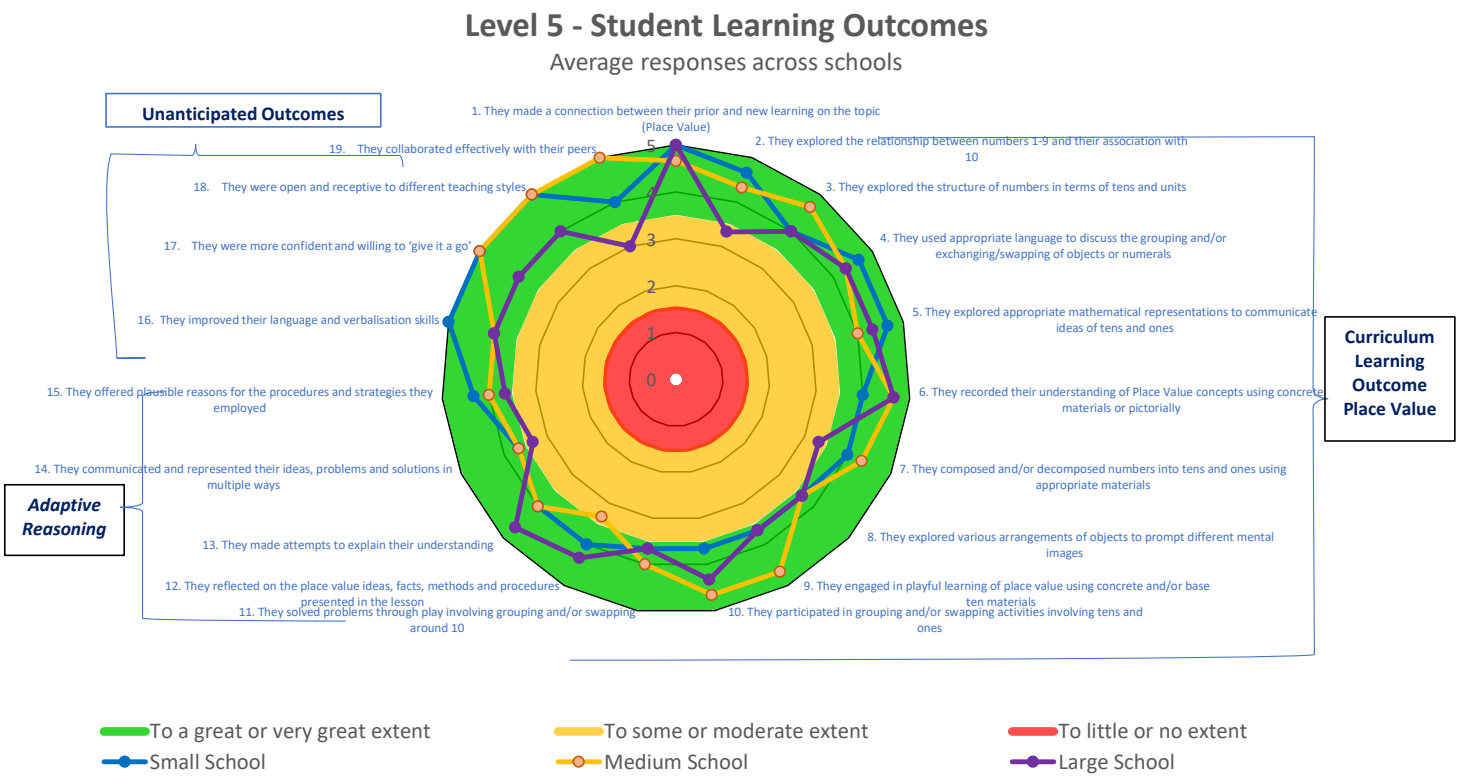

Figure 11. Achievement of success indicators at Level 5 – Children's learning outcomes

Curriculum Learning Outcomes for Place Value

Across all three schools, the teachers reported that a notable outcome in terms of children's learning was how the children made explicit connections between their prior learning and Place Value, a new mathematical topic introduced at infant level in the new primary mathematics curriculum. Sandra expressed satisfaction, and to some extent surprise, at the way in which the children in her school made connections, particularly one child in the class who typically finds mathematics difficult. On reflection of the second Research Lesson, Maria noted "Child X talked about needing a banker to swap her units for tens, she was making connections with the first Research Lesson". Similarly, during the post-Research Lesson discussion in cycle 2, Lauren noted, "they were able to tell us so much and recall their experiences from the last lesson", and Lorraine remarked, "within five minutes you could tell they were drawing on previous knowledge". The researcher also observed the children in the small and medium school make explicit reference to learning from prior Research Lessons during the intervention. For Selena, success in this area of children learning stemmed from the teachers taking their planning and teaching cues from the children themselves "going from where the children are at, rather than where we think they should be". On balance, Leah commented that it may have been more obvious that the children were making connections as the teachers were explicitly aware of and looking for this.

On evaluating the first Research Lesson, teachers in the small school noted that the children would have benefited from additional time and opportunities to explore different ways of talking about and representing their understanding. Whilst not explicitly reported by the teachers in the other schools, this was recorded by the researcher in the cycle 1 field notes for the medium and large school also. Following Research Lesson 2, teachers from the small school reported that when their children were allowed to take their time and were not rushed to produce an answer, the quality of their responses and representations was better. The teachers in the medium school reported that initially the children used language that made sense to them (for e.g. linked to card trading game) when communicating about their learning (for e.g. discussing the swapping or 'trading in' of units for tens). By the final Research Lesson, the teachers reported that many of the children had broadened the language they used to describe the swapping and exchange of tens and units, and importantly, as Megan noted, that they did so in a variety of different contexts. Molly noted that a particular improvement in children's learning observed in Research Lesson 2 and 3

was how many different ways the children devised to talk about and represent (show) multi-digit numbers. During post-Research Lesson discussion in cycle 3, Lesson Study teams, across each of the schools, reported that the children had used suitable language in appropriate contexts to talk about Place Value.

Another outcome highlighted by Lesson Study teams in the small and large school as note-worthy, was how well the children responded to open-ended and problem-centric questions such as 'what are we going to do?' and 'how might we figure out how to solve this?' Megan reported that when they had set up the learning task to be appropriately challenging for the children and posed "the right questions [higher-order open-ended questions], it was obvious to see that they were thinking and talking through their ideas". In giving a more specific example, Molly reflected on Research Lesson 2, "the tasks really made them think about how the position of the number is linked to the value to [of] the numeral". Following the final Research Lesson, Molly commented that she found the children to be much more comfortable with problem-solving and particularly in attempting to give different solutions. The researcher noted the extensive use of role-play in Research Lessons and also the increasing number of 'why' questions posed to children, resulting in children observably and explicitly thinking and reflecting during the lessons.

Sonya and Leah reported that they were surprised at how few materials they required to support children's learning in Place Value in the Research Lessons. Similarly, Maria noted

> *"usually when something new like the curriculum comes out, I would run to the catalogues to see what resources we would need to buy, but we really wouldn't have need to buy anything new to teach what we did, even though it [Place Value] is new to infants".*

To substantiate these claims, it was noted by the researcher that teachers, across each of the schools, had used very simple concrete materials (i.e. base-ten blocks and lollipop sticks) in their Research Lessons.

Adaptive reasoning

Children in the medium and large school were observed from the outset to be comfortable in talking about, justifying and explaining their thinking. Lauren reported, "they were able to use mental images, but they also used their fingers…. and we prompted them to think about how their learning was relevant to them". The small school Lesson Study team

pointed to a number of difficulties the children had initially with reasoning, particularly with not knowing what to do when they were asked to explain themselves or talk about what they were doing (and why). The researcher observed that a number of children were also visibly hesitant to attempt different ways of exploring the concrete materials they were working with. These teachers expressed how the approach adopted in the first Research Lesson was a different way of learning for the children and that they would need some further encouragement to work in this way. Whilst impossible to discern exactly why the children in the small school were more reluctant to talk and explain their thinking, the teachers inferred that given the multi-class setting, it can be more challenging to listen to the children's responses and explanations for their thinking, whilst simultaneously managing the learning of children at other class levels. An alternative explanation for children's reluctance to talk and explain their thinking suggested by Selena was a possible lack of language or vocabulary, "I think they did explain in a way that made sense to them, but maybe not to everyone else". Notwithstanding, in later post-Research Lesson discussions, the teachers in the small school reported being particularly impressed with children's progress in explaining and justifying their thinking.

Correspondingly, the researcher observed the teachers give dedicated attention, during the planning stage of subsequent Lesson Study cycles, to vocabulary building on the topic of Place Value. In addition to improved use of vocabulary, teachers in the small and medium school also remarked that many of the children became increasingly forthright and confident in their contributions to the class discussions with each cycle of Lesson Study. Across all schools, teachers reported that children responded well when provided with opportunities to talk and interact with their peers, "when they were put into pairs, you could visibly see them thinking and going 'Aha'" (Molly).

A particular theme to emerge from post-Research Lesson Discussions following Research Lessons 2 and 3 was the importance of allocating time and space for the children to think and respond. Selena reported that once provided "they [the children] did offer good reasons and explanations for the thinking and were able to describe this in a way that made sense to us and to the other children". To this Sonya added, "we gave them plenty of time to reflect on their [Place Value] ideas …… giving waiting time to the children was something that really made a huge difference". These teachers reported that in a busy multi-grade classroom it can be difficult to dedicate time to be present and really listen to what the children are saying [what responses they are giving to the questions we pose] but that

given how children progressed, this has been the most significant and insightful outcome from Lesson Study in terms of children's learning in the small school.

In a similar way, Leah commented also at how the set-up of the Research Lesson and the way observing teachers spread out throughout the room during Research Lessons meant that the collective Lesson Study team were able to get a keener insight into children's reasoning skills and the ways in which they explained their understanding. Furthermore, teachers in the medium and large school reported that having proximity to children and increased opportunities to listen to the children's responses are important in supporting the development of children's reasoning skills.

Finally, at least one teacher from each of the three schools noted that asking 'why' questions was really powerful to facilitate the development of children's reasoning and thinking. Lorraine reflected that in one lesson "we asked them questions like – 'why did you give him that [amount of cubes]?', and even though the amount wasn't right, they gave plausible explanations that made sense to them". Following the final Research Lesson, all teachers reported that the children had improved the quality of their responses to 'why' questions.

Unanticipated Outcomes

At the end of the Lesson Study intervention, participants reflected on the impact of Lesson Study on children's learning outcomes and identified four additional outcomes at Level 5. Although not anticipated, the teachers reported that the children (1) improved their vocabulary and verbalisation skills; (2) were more confident and willing to 'give it a go' (i.e. to take risks, try or make attempts when unsure) (3) were open and receptive to different teaching styles; and (4) collaborated more effectively with their peers.

On observation of the first Research Lessons, the researcher observed that children tended to use limited language to explain themselves when asked open-ended questions. The researcher noted that as each Lesson Study cycles progressed, the children demonstrated a broader use of vocabulary and more sophistication in how they articulated their ideas, particularly in the small and medium school. At different intervals of the study, Lesson Study teams reported that the children had improved their language and verbalisation skills in a way that was unexpected. Following Research Lesson 2, Maria commented, "they were clear in what they were saying and using terminology that I wasn't expecting to hear".

Many teachers also reported that the children demonstrated increased confidence over the intervention period, remarking specifically on children's increased willingness and proclivity to 'give it a go' or make attempts to engage with the lesson ideas, even when there was a degree of uncertainty. Sandra noted how one of the children in her school who was typically reluctant and quiet "really opened up and spoke out". Maria and Molly reported that with the additional space provided to them, the children in their school took more control and initiative with their own learning. "I found them far more confident to answer challenging questions and to give it a go" (Molly). Similarly, Lauren reported that upon engaging new ideas, children in her class "were more willing to take it on and give it a stab".

This increased confidence also appeared to extend to children's confidence and openness in working with other teachers. In the large school Leah reported "I was impressed how having four teachers in the classroom (one teaching, three observing [including the researcher]) didn't 'knock a shake out of them' and I think it helped them be more adaptive". By way of explanation, Sandra noted, "the children's learning became stronger because of what they were doing. It didn't matter who was teaching them, they engaged with all of us and were open to different teaching styles". Correspondingly, the researcher observed little unease from the children when the Research Lessons were taught by one of the visiting teachers.

Finally, Lesson Study teams in the medium and large school reported being particularly impressed by how well the children in their schools worked with and assisted their peers in the Research Lessons. Maria noted working in small groups, "the children were supporting each other, taking turns and explaining themselves to each other … they did more than just communicate with each other, they were actually supporting and assisting each other". Sandra and Sonya described the children's level of engagement over the intervention period as 'incredible'.

Causal Attribution at Level 5

At the end of the intervention, participants agreed and categorised Lesson Study determinants according to the extent with which they could be attributed to the outcomes at Level 5; namely as most, least and not responsible for organisational change and support at school level. The three most critical determinants of success identified by the group were: (1) trying out new teaching ideas and strategies; (2) having professional conversations around the Research Lesson; and (3) building on children's prior knowledge

and misconceptions. The categorisation and ranking of Lesson Study determinants at Level 5 is outlined in the following table. The three determinants identified by the participants as most critical are highlighted in bold.

Table 25. Categorisation and ranking of determinants at Level 5

Lesson Study determinants for outcomes at Level 5		
Most responsible	**Least responsible**	**Not responsible**
• Time and Space (to think about teaching and assessment ideas) (A) • Opportunities to share and reflect (B) • Facilitated Discussions (D) • Investigating practice (E) • ***Trying out new teaching ideas and strategies (F**) • Observing Lessons in Real Time (G) • ***Having professional conversations around the Research Lesson (H)** • ***Building on children's prior knowledge and misconceptions (L)** • Analysing and evaluating children's responses to teaching activities and instruction (M) • Directly seeing children's progress (O)	• Working with Knowledgeable Other (C) • Working Collaboratively with colleagues (I) • Planning Collaboratively (J) • Collective knowledge and expertise of peers (K) • Teacher Toolkit (Curriculum support materials) (N)	•

On consideration of other mediating factors which could be attributed to children's learning outcomes, aside from Lesson Study; participants highlighted a number of different initiatives that had taken place in their schools over the course of the intervention period which may also have contributed children's learning. Selena noted that in her school, the senior infant class had spent some time learning about money, integral to which are base-ten concepts. The medium school had recently conducted an assembly on the theme of children's human rights which Maria noted may have led to more critical thinking. Moreover, children in the medium had also partaken in a food and nutrition initiative

where different foods came in packs of ten, which may have contributed to the children's understanding of ten. Finally, Leah added that senior infants in the large school had undertaken a unit of learning on persuasive writing and were encouraged to articulate with justification e.g. 'I like this because….' and this could also have possibly assisted the children to explain themselves and develop their skills of reasoning. Furthermore, Lauren indicated that the teachers' extant knowledge and experience of teaching Place Value with the current primary mathematics curriculum (DES, 1999) would likely have contributed to the success of children's learning in the context of teaching this topic with the new curriculum. In response, Leah noted that Place Value is not a learning objective for senior infants in the current primary mathematics curriculum (DES, 1999), as such teaching Place Value to children at senior infant level (or grade) is new to the new primary mathematics curriculum.

On consideration of possible inhibitors to Lesson Study achieving a greater level of success or impact on children's learning outcomes, the teachers offered a number of explanations. Leah suggested that being in a situation "where children are struggling or are wrong", as observed also by other teachers during the Research Lessons, may be unfamiliar or uncomfortable for them. Maria highlighted how language tends to pose a barrier for some children regardless of the learning involved. Sandra agreed and attributed this to the increasing prevalence of technology in children's lives, something which she foresees as being an issue in curriculum enactment with and beyond mathematics in the future. In addition, Maria noted that some children have little or no explicit experience of maths outside of school.

On comparing and contrasting Lesson Study with traditional CPD, Sandra noted "I don't think it [traditional CPD] encourages us as much to think about what it looks like in our own classroom". According to Maria, Lesson Study and traditional PD, as she has experienced it in her teaching career spanning over 30 years, are "incomparable". In discerning the main differences, Maria noted

> *"with Lesson Study the focus is on 'how' you teach the curriculum, as opposed to 'what' you teach, this CPD model [Lesson Study] turns it on its head and you look at what the child is actually learning in the context of your own classroom"*.

Lauren agreed, commenting,

> *"traditional in-service would not have encouraged us to engage with, monitor and think about the children's learning as much as this [Lesson Study] has. The in-service would have been about the curriculum itself more so that on the children's learning"*.

On concluding this discussion, Megan noted the need for more sustained support for teachers to engage with a new curriculum that has traditionally been provided to teachers, adding

> *"if we are going to be given CPD with the next maths curriculum, I think that it would be a far better use of our time to plan with it, actually try out lessons in the classroom and talk about how it worked out in reality than sitting in front of a PowerPoint presentation for two days"*

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4.2.6 Refined Theory of Change

To refine the ToC, the outcomes were updated to include the unanticipated outcomes which were reported by teachers at the end of the Lesson Study intervention, and as discussed above [See sub-section 4.2.4] also include the identification of 'teachable moments' at Level 4. Moreover, the list of determinants was updated to include 'directly seeing progress in children's learning', which participants had not anticipated on first developing the programme theory. Guiding questions for refining the ToC are summarised in table 17 and the methods used to handle the data in refining the programme theory are outlined in sub-section 3.5.7.

The refined ToC is outlined in figure 12 and reflects the amendments and additions made to the initial ToC tested in the study.

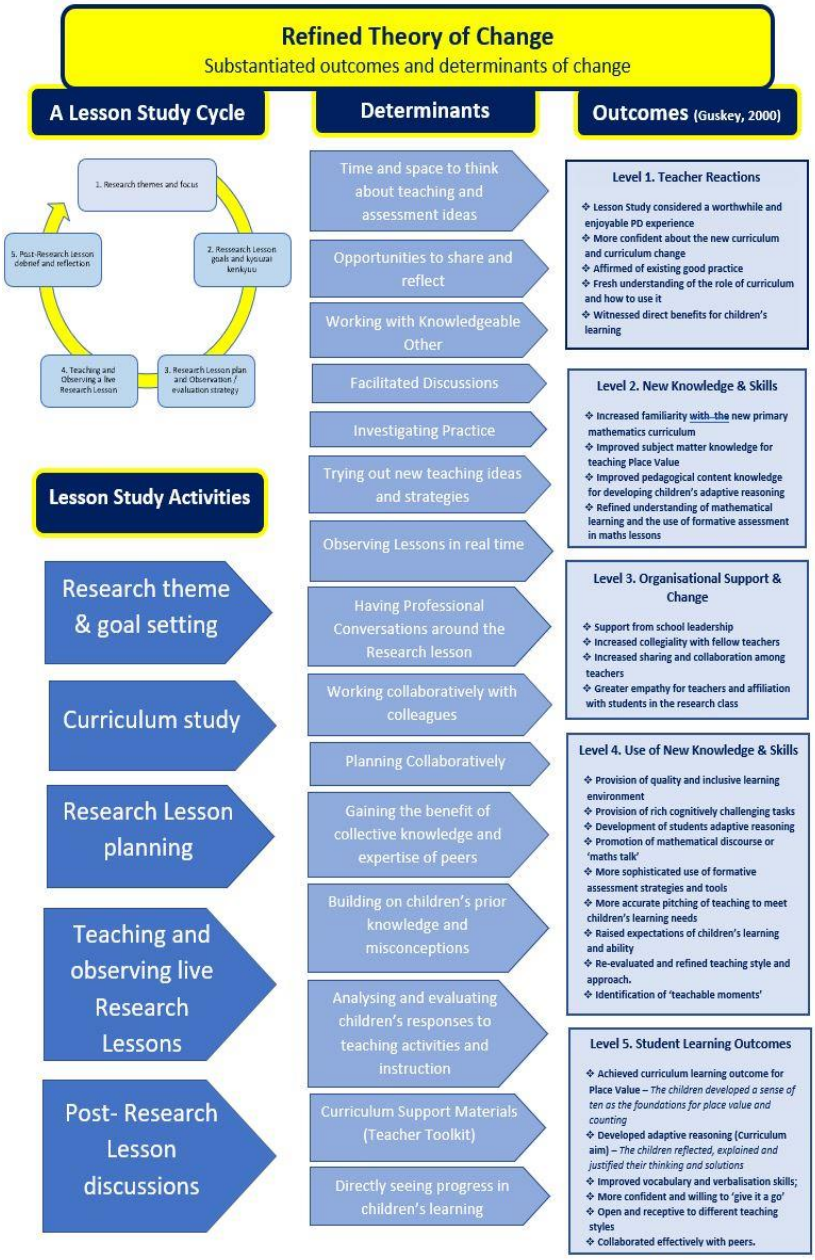


Figure 12. Refined Theory of Change – Substantiated outcomes and determinants of change

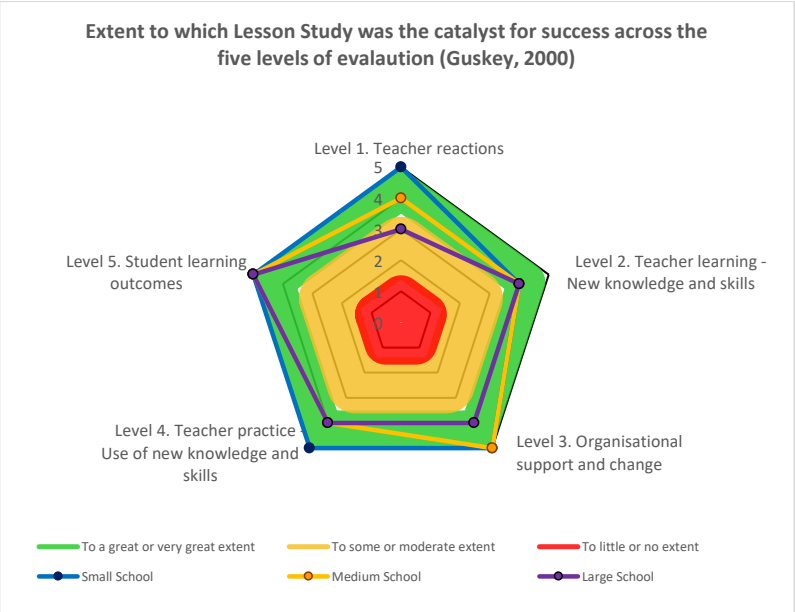
4.3 Summative evaluation of Lesson Study as a curriculum enactment support

In addition to evaluating Lesson Study using the programme theory framework (ToC), data on teacher's summative evaluation of Lesson Study as a catalyse of curriculum enactment and change was collected. Findings include teachers' explicit rating of Lesson Study as a PD model to support and catalyse curriculum enactment and change. They also include a summary of teachers' categorisation and ranking of Lesson Study determinants at each level of evaluation. The methods used to handle this data are outlined in sub-section 3.5.4.

4.3.1 Lesson Study as a catalyst of curriculum change and enactment

The following table shows how each of the Lesson Study teams rated Lesson Study. Using the same six-point Likert scale was employed as with all other rating activities in the study (Rating key: 0 = not at all, 1 = little or no extent, 2 = to a small extent, 3 = to a moderate extent, 4 = to a great extent, 5 = to a very great extent). Ratings within the green zone indicate that teachers agreed that in their school, Lesson Study was attributed to success at that level to a great or very great extent. Ratings within the amber zone indicate that Lesson Study was attributed to some or moderate extent, while rating in the red zone signifies that Lesson Study was attributed to success at this level to little or no extent.

Table 26. Lesson Study as catalyst for success across the five levels of evaluation



All participating teachers contended that, in general, Lesson Study could be confidently attributed to supporting them to enact the new primary mathematics curriculum. Notably, while there were slight divergences in how each of the schools rated Lesson Study, particularly in terms of how its impact on their reactions and levels of satisfaction; there was full consensus among the group that in their view, Lesson Study was substantially determinative of children's learning outcomes in each of their schools. Moreover, unanticipated outcomes and qualitative findings substantiated by evidence from the research also support the notion that Lesson Study was a catalyst for curriculum change and enactment in these schools.

4.3.2 Categorisation and ranking of Lesson Study determinants across all five levels of evaluation

With the assertion from the nine participating teachers that Lesson Study was, in general, strongly attributed to success at each level of evaluation, it is useful to concomitantly cross-examine the categorisation and ranking of individual Lesson Study determinants for each of these respective levels of evaluation. The following table provides a summary of these

findings at a glance. Boxes labelled 'N' signify that the determinant was categorised as 'not' responsible for outcomes at that given level. Boxes labelled 'L' mean that the determinants was categorised as 'less' responsible for outcomes while boxes labelled 'M' mean that participants categorised the determinant as 'most' responsible for outcomes at that given level. Importantly, boxes labelled with a star icon ★ spotlight the three determinants which were identified by participants as being most critical for the success of outcomes at each level.

Table 27. Categorisation and ranking of Lesson Study determinants across five levels

Categorisation and ranking of Lesson Study determinants across five levels of evaluation						
		Level 1	Level 2	Level 3	Level 4	Level 5
A	Time and Space (to think about teaching and assessment ideas)	M	★	M	★	M
B	Opportunities to share and reflect	★	M	★	M	M
C	Working with Knowledgeable Other	M	L	L	L	L
D	Facilitated Discussions	L	L	M	M	M
E	Investigating practice	M	M	L	M	M
F	Trying out new teaching ideas and strategies	L	M	L	M	★
G	Observing Lessons in Real Time	★	M	M	M	M
H	Having professional conversations around the Research Lesson	L	M	★	★	★
I	Working collaboratively with colleagues	M	L	★	M	L
J	Planning Collaboratively	M	L	M	M	L
K	Collective knowledge and expertise of peers.	L	★	M	M	L
L	Building on children's prior knowledge and misconceptions	L	M	L	M	★

M	Analysing and evaluating children's responses to teaching activities and instruction.	M	★	L	★	M
N	Teacher Toolkit (Curriculum support materials)	N	L	N	L	L
0	Directly seeing children's progress	★	M	L	M	M

From analysis of the pattern of results in table 27, a number of findings emerge. Three Lesson Study determinants were categorised as 'more' responsible for outcomes across each of the five levels of evaluation. These were (1) having time and space (to think about teaching and assessment ideas); (2) opportunities to share and reflect; and (3) observations of live lessons. Notwithstanding the centrality of these determinants to the success of Lesson Study, having professional conversations around the Research Lesson was rated by teachers as being one of the three most critical determinants for outcomes achieved at the later three levels of evaluation (Level 3, 4 and 5). Moreover, with a few exceptions, the majority of determinants rated as 'more' responsible for outcomes at Level 2 (teachers' learning) were similarly rated at Level 4 (teachers' practice). Correspondingly, two determinants (1) time and Space and (2) analysing and evaluating children's responses were ranked as 'most critical' to success at both Level 2 and 4.

Of note, the results show that the determinants of Lesson Study which teachers reacted more positively to, or were more satisfied with (at Level 4), were not rated equally as high in terms of their contribution to children's learning outcomes. In contrast, the three determinants rated by participants as being most critical to the success of children's learning outcomes (Level 5) were categorised by participants as 'less responsible' for teachers' reactions or level of satisfaction with Lesson Study (at Level 1). These critical Level 5 determinants (a) trying out new teaching ideas and strategies; (b) having professional conversations around the Research Lesson; and (c) building on children's prior knowledge and misconceptions were not spotlighted in the Level 1 evaluation. These findings suggest that an evaluation of Lesson Study solely at Level 1, as is typical of the majority of PD evaluations (King, 2014) would have been a poor indicator of the effectiveness of Lesson Study as a model of PD to enact the curriculum.

In a similar way, the more collaborative aspects of Lesson Study, such as working with peers, planning collaboratively and harnessing collective knowledge, were attributed to outcomes at Level 3 (organisational change and support) and Level 4 (teacher use of knowledge and skills); however they were attributed to children's learning outcomes to a much lesser extent.

Notably, the teacher toolkit, a suite of 11 curriculum support materials provided to participants [See sub-section 3.4.1 - Figure 4], were not deemed by participants to be an important determinant of success for outcomes across any of the levels, but in particular in terms of teachers reactions and organisational support and change where they were categorised as having 'no responsibility' for outcomes. Equally, the participants afforded relatively little credit to working with the Knowledgeable Other as a determinant of success, with the exception of Level 1 with Maria reporting "I really enjoyed our Skype chat with the maths lecturer but I don't think that really made much of a difference to what we actually taught, we did the research and work for that ourselves".

4.4 Impact of Lesson Study on objective measures of teacher practice and children's learning outcomes

To triangulate the findings on the impact of Lesson Study, three anticipated outcomes detailed in the ToC namely (i) teacher questioning, (ii) children's understanding of Place Value, and (iii) children's reasoning skills; were isolated and further evaluated using objective measures. The assessment criteria and methods used to collect and handle the data are outlined in sub-section 3.5.3 [See - Objective measures of impact] and summarised in table 28 below. Reliability checks of findings were also conducted, as discussed in sub-section 3.6.3 [See – Inter-rater and inter-coder reliability].

At Level 4, teacher questioning, specifically (i) the proportion of question types and (ii) the frequency of open-ended questions posed to children were measured by the researcher. Guskey (2002) holds that because implementation of a given intervention can be a gradual and uneven process, progress may need to be measured at several time intervals. Accordingly, over 17 hours of teacher questioning data was captured via audio recordings of maths lessons, gathered at four distinct points of the study; (1) pre-Lesson Study, (2) during the Research Lesson taught, (3) one month post-Lesson Study and (4) again 4 to 6 months post-Lesson Study. Findings of the impact of Lesson Study on teachers' questioning

is presented below in section 4.4.1. Detailed results of measures of teachers' questioning can be found in Appendix 2.

At Level 5, children's understanding of Place Value and children's reasoning skills were objectively measured to triangulate findings on the impact of Lesson Study on children's learning outcomes. To do so, a criterion-referenced assessment, co-designed with participating teachers, was administered to the research class (senior infants) at two intervals of the study (i) pre-Lesson Study and (ii) post-Lesson Study [See section 3.5.3 – Table 12 and Figure 5]. The pre-Lesson Study assessment took place two to four weeks before the Lesson Study intervention commenced, and the post-Lesson Study assessment was repeated in the month following the final Lesson Study cycle. In total, 52 senior infant children were assessed in the study; 10 children in the small school, 24 children in the medium school and 18 children in the large school. The results of these pre-and post-Lesson Study assessments of the children's understanding of Place Value and children's reasoning skills are presented in sub-sections 4.4.2 and 4.4.3 respectively. Detailed results of measures of children's understanding of Place Value and adaptive reasoning skills, by school and overall can be found in Appendix 3 and 4 respectively.

Table 28. Summary of objective measures of impact

	Area of investigation	**Data source**	**Evaluation interval**
Level 5 – Children's learning outcomes	Understanding of Place Value	Criterion referenced assessment	Pre- and post-Lesson Study
	Reasoning Skills (Quality and type of responses)	Teacher/Student interview	Pre- and post-Lesson Study
Level 4 – Teachers' use of new knowledge and skills	Teacher question types	Audio recorded maths lessons	Four evaluation points •Pre-Lesson Study •Research Lesson •1-month post-Lesson Study •4-6 months post – Lesson Study
	Frequency of open-ended questions		

4.4.1 Impact on teacher questioning

To measure the impact of Lesson Study on teachers' questioning, a conceptual framework (adapted from Kim, 2015) was employed to filter, code and analyse eligible question types

that were captured in 35 audio clips[19] containing approximately 17 hours of recordings of mathematics lessons. Closed-ended questions were categorised as questions (i) asking for factual information **[AI]** and (ii) asking for confirmation **[AC]**. Open-ended questions were categorised as questions (i) asking for explanation based on experience/data **[AE]**, (ii) asking for self-evaluation of reasoning **[AF]** and (iii) asking for evaluation of other's reasoning **[AFO].** For a more detailed outline of how the data was collected and handled [See sub-section 3.5.3 – Teachers' questioning].

The investigation found that teacher questioning changed over the course of the study. The following figure 13 presents the average breakdown of question types posed by the nine teachers. Findings show that compared with pre-Lesson Study measures of teachers use of closed questions (75%), there was a reduction in teachers use of closed questions over the remaining evaluation period; 46.9% during Lesson Study, 41.1% one-month post Lesson Study and 44.2% four to six months following Lesson Study. Analysis of differences in the types of closed questions posed by teachers over the evaluation period show that the biggest reduction was to teachers' use of questions which ask for confirmation (AC). Cross-analysis of the teacher's individual use of questions [See Appendix 2] shows a similar trend in terms of the changes to teachers' use of closed and open-questions over the evaluation period.

[19] One teacher retired following the Lesson Study intervention accounting for why 35 clips were captured in total as opposed to 36.

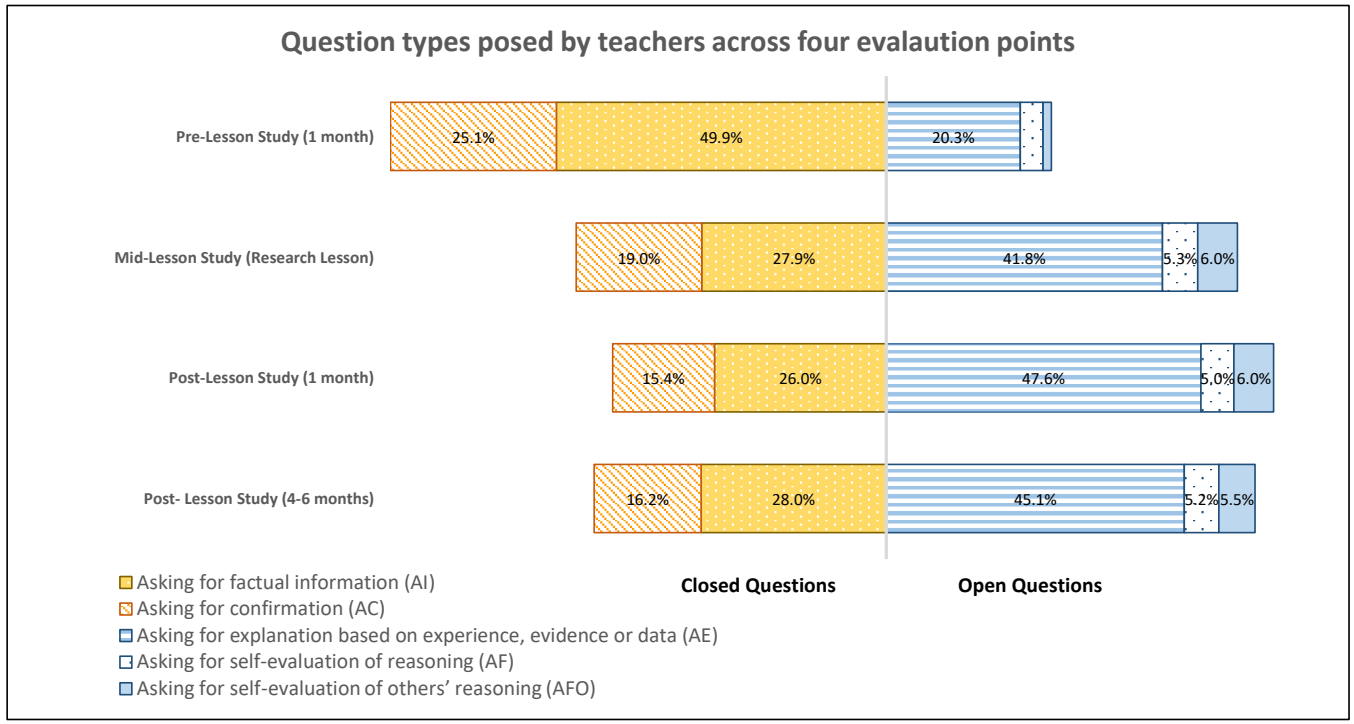


Figure 13. Question types posed by teachers across four evaluation points

Note: Data labels for percentages of less than 4% were not included in this graph

Conversely, there was an increase in the proportion of open-ended questions posed by teachers in the four maths lessons. Analysis of the audio recording of maths lessons captured before Lesson Study commenced showed that, on average, one quarter (25%) of questions posed by teachers fell into the open-ended category. Comparatively, the average proportion of open-ended questions posed by teachers in the Research Lessons (recordings captured mid-intervention) more than doubled to 53.1%. In the month following Lesson Study, analysis of audio recorded lessons showed a further increase of 5.5% in the average proportion of open-ended questions posed (58.6%). Analysis of the final suite of audio recordings, captured four to six months following the Lesson Study intervention showed a decrease of 2.8% in teachers proportional use of open-ended questioning in their maths lessons (55.8%). Statistical testing was not applied to teachers questioning as there were qualitative differences between the questions, rather than quantitative.

On examining the breakdown of question types posed by teachers [See Appendix 2], the findings show that teachers proportional use of questions which ask for explanation based on experience, evidence or data (AE) doubled in the Research Lesson (41.8%) compared with pre-Lesson Study measures (20.3%). There was a further increase in the maths lesson recorded one-month post-Lesson Study to 47.6%. This measure reduced by 2.5% in the final maths lesson (45.1%). In a similar way, teachers' proportional use of questions which asked for self-evaluation of reasoning (AF) and self-evaluation of others reasoning (AFO) were found to follow a similar trend over the evaluation period. Notably, AFO questions which comprised 1.3% of eligible questions posed by teachers in the pre-Lesson Study recording, increased more than three-fold to 6% of questions posed in the Research Lesson and maths lesson recorded one-month post-Lesson Study. As with the other open-ended question types, there was a reduction in the use of AFO questions in the maths lesson recorded four to six months post-Lesson Study. A full breakdown of the question types posed by individual teachers across the four points of evaluation can be found in Appendix 2.

In addition to the proportion of question types posed during the maths lessons, the same audio recordings were also analysed to determine the frequency of open-ended questions posed by teachers in these maths lessons. As before, the full breakdown of lesson durations and frequency of open-ended questions can also be found in Appendix 2. The average frequency of these question types posed by all nine teachers across each of the four evaluation points is presented in the following figure.

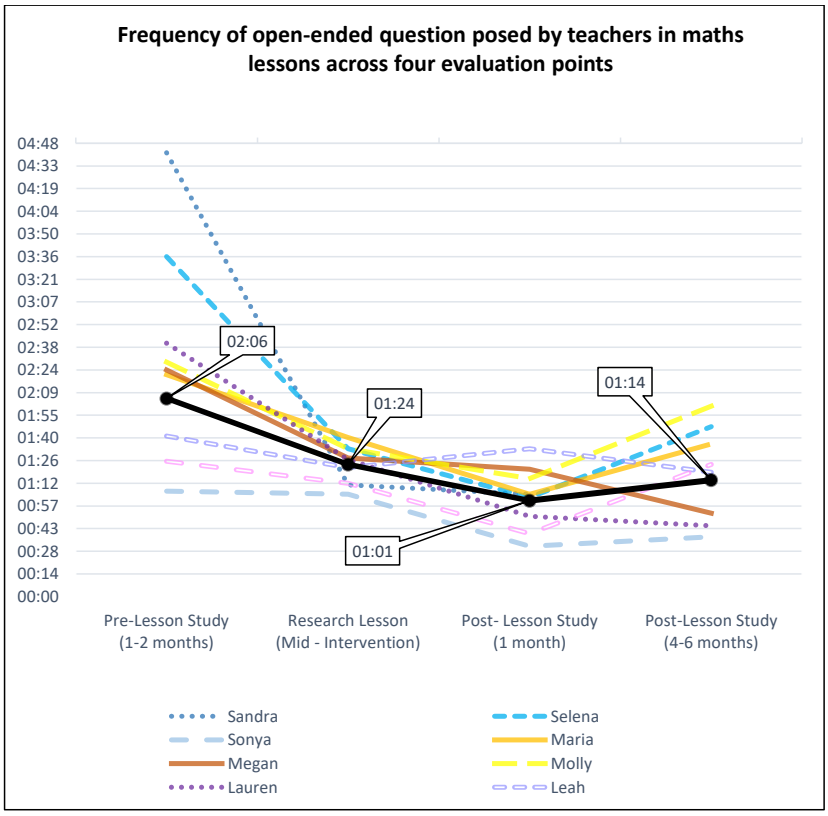


Figure 14. Frequency of open-ended questions posed by teachers across four evaluation points

Analysis of the pre-Lesson Study recordings showed that, on average, participants posed one open-ended question every two minutes and six seconds (2:06). During the Research Lessons, the average frequency for asking open-ended questions increased to once every one minute and twenty-four seconds (1:24). In a similar trend to the proportion of open-ended questions posed over the evaluation period, the frequency for posing open-ended questions peaked in the month following the Lesson Study intervention to once every one minute and three seconds (1:03). The average frequency of open-ended questions posed in the final lesson recorded 4 to 6 months following the intervention were less frequent by 15 seconds (1:18).

Pre-Lesson Study maths lesson recordings showed a wide variance in how frequently teachers posed open-ended questions in the four maths lessons. The least variance was evident in the Research Lesson, while analysis of the frequency of teachers' use of open-

ended question in the two final evaluation points showed increasing variance, although not to the same degree as found pre-Lesson Study. Given that the most striking shift in teachers use of open-ended and closed questions was found during the Research Lesson (which was observed by the researcher and the Lesson Study team), when looking for explanations for teacher questioning findings it is worth considering the Hawthorne Effect, which suggests that teachers' behaviour can change because they are being observed (Brannigan and Zwerman, 2001). Notwithstanding, teachers increased use of open-ended questions in their maths lesson sustained over the evaluation period, albeit with the teacher's understanding that 'teacher talk' captured in the lesson recordings would be analysed by the researcher, again potentially regenerating the Hawthorne Effect.

4.4.2 Impact on children's understanding of Place Value

The following figure 15 presents children's pre- and post- Lesson Study assessment scores on a criterion referenced assessment of their understanding of Place Value. This assessment tool is described in detail in sub-section 3.5.3 [See - Children's understanding of Place Value]. To support the reader to interpret the figure, the following criteria were used to assess the quality of children's understanding of Place Value, or more specifically the extent to which the children could

1. Appreciate that the position of a digit indicates its value – that digits to the left have the greatest value, digits to the right have the least
2. Model and represent the value of a two-digit number (between 11-19) to communicate the idea of tens and units
3. Identify and write the number that is 1 more, 1 less, 10 more than a two-digit number (between 11-19)
4. Compose and decompose a two-digit number (between 11 -19) into tens and units.

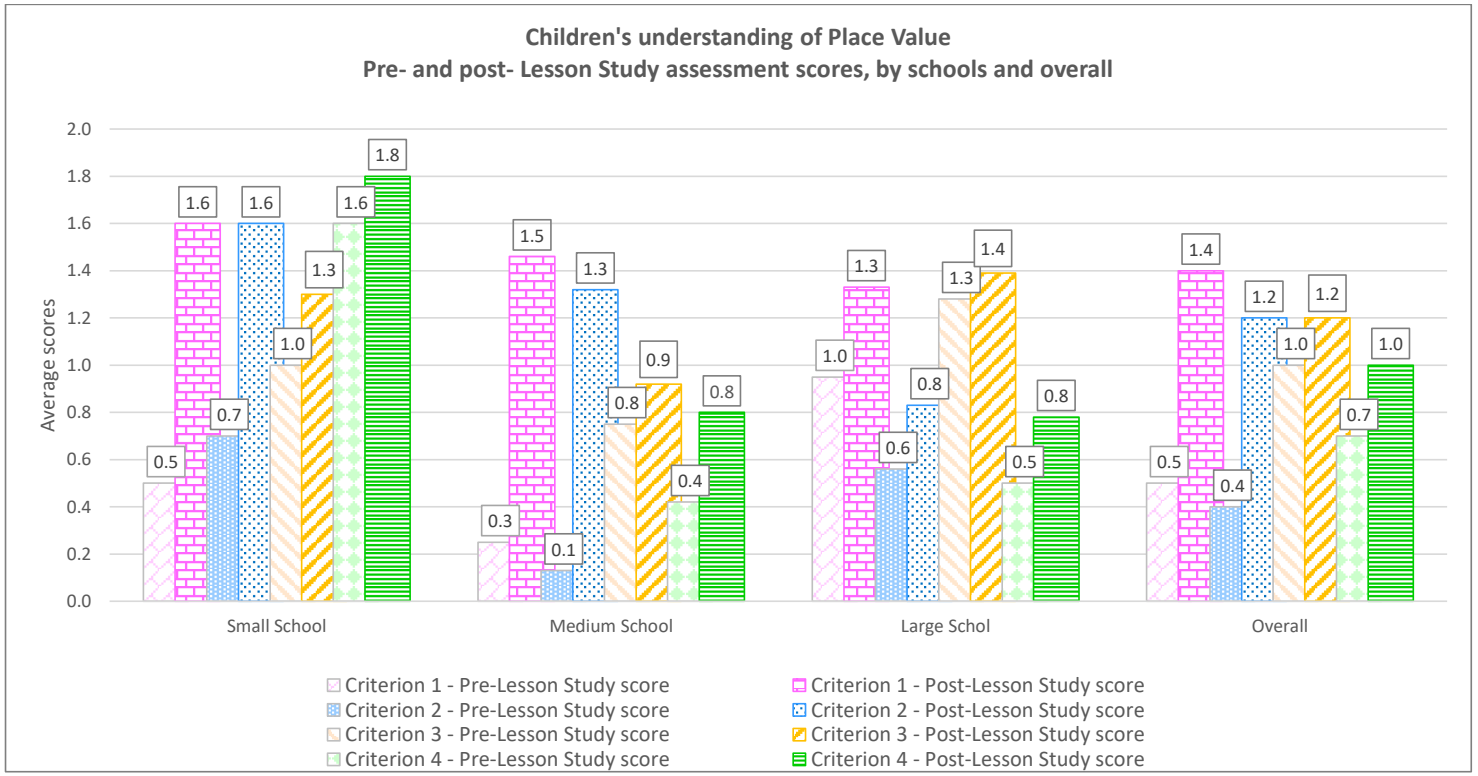


Figure 15. Children's understanding of Place Value: Pre and post Lesson Study assessment scores, by schools and overall

A comparative analysis of Place Value assessment scores across the three schools shows that children in the small and the medium school experienced the greatest improvements in their understanding of Place Value, with average score increases of 2.5 scores and 3 scores respectively, representing average positive improvements of 31.25% and 37.5% respectively. Notwithstanding average pre-Lesson Study assessment scores showed that children in the large school performed at a higher rate in general, children's understanding of Place Value showed an average improvement of 1.05 scores on post-Lesson Study assessments, a positive difference of 13.1% compared with pre-Lesson Study assessment scores. Overall, the difference between the pre- and post- Lesson Study assessment scores for the average child involved in the study was 2.2 scores. Out of a possible 8 scores, this shows an average improvement of 27.9% in children's understanding of Place Value following their teacher's participation in Lesson Study. A full breakdown of assessment scores by school and overall can be found in Appendix 3. Of note, children in senior infants in Ireland do not receive explicit instruction in Place Value or adaptive reasoning as part of their current curriculum provision. As such, this gives further confidence to the findings in attributing improvements in children's understanding of Place Value to Lesson Study.

Statistical analysis and testing were applied to the children's Place Value assessment scores. Three tests, namely the Paired Sample T-test, Cohen's D and Cronbach's Alpha was applied to this data to test for statistical significance, effect size and reliability respectively [see Appendix 5]. The overall paired sample t-test statistics show that the mean score (N=52) of children's understanding of Place Value pre-Lesson Study was 2.52 (SD = 2.11) compared with 4.81 (SD = 1.92) post-Lesson Study which demonstrates a statistically significant improvement in the children's understanding of Place Value, $t(51) = 8.72$, $p < .001$. Statistical testing of individual school scores shows that quantitative differences between the school are not statistically meaningful (small school, n=10; medium school, n=24; large school, n=18), however they have been included in Appendix 5 for descriptive purposes. The effect size of the difference between the overall scores pre- and post-Lesson Study was d = 1.14, indicating a large effect size and strong difference. As before, analysis of individual school scores are not statistically meaningful owing to the small sample sizes involved, however they do provide an indication of school differences and the individual school effect on the overall differences. As evidenced in Appendix 5, the average pre- and post- Lesson Study Place Value assessments scores of children in the small and medium schools both demonstrated a strong difference, with the large school scores demonstrating a moderate to strong difference. Finally, reliability testing showed that whilst the scores have statistical

significance, the pre-Lesson Study Place Value scale had a low reliability (α = .47) as did the post-Lesson Study scale (α = .58) owing largely to the fact that there were only four items on the assessment.

4.4.3 impact on children's reasoning skills

The following figure 16 presents children's pre- and post- Lesson Study assessment scores on a criterion referenced assessment of their reasoning skills. This assessment tool is described in detail in sub-section 3.5.3 [See - Children's adaptive reasoning skills]. To support the reader to interpret the figure, the following criteria were used to assess the quality of children's reasoning skills, or more specifically the extent to which the children could

1. Explain why they chose a particular number, strategy or solution to justify their answer
2. Justify their solutions with plausible reasons
3. Think logically about the relationship between different representations of a number using Place Value concepts

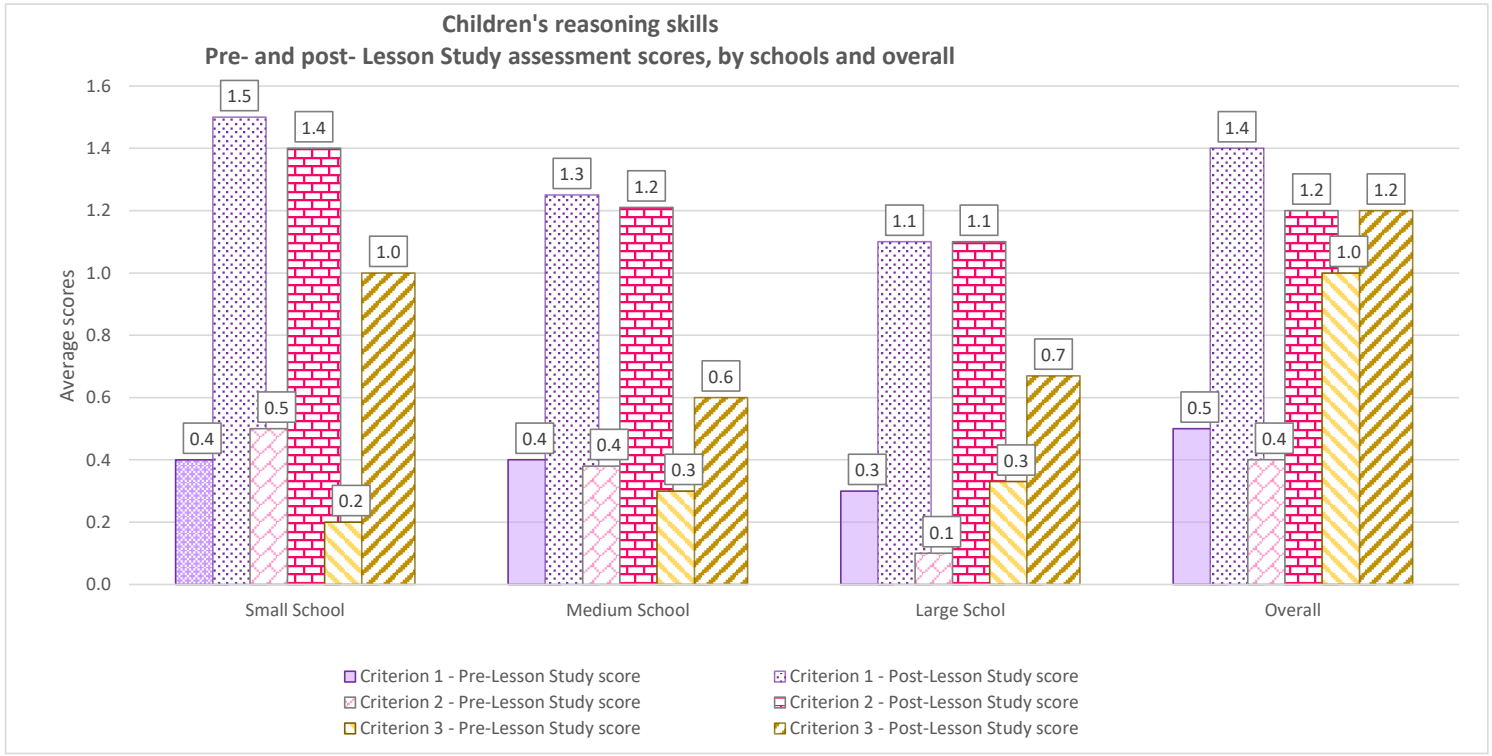


Figure 16. Children's reasoning skills: Pre- and post-Lesson Study assessment scores, by schools and overall

A comparative analysis of children's overall reasoning skills assessment scores across all three schools show that the average child was found to demonstrate improvements in his/her reasoning skills across each of the three criteria tested. The degree of improvement across the three schools was relatively similar, with the average child in each school improving their reasoning skills in the areas test by at least a third. Notwithstanding, the greatest proportionate gains were achieved by children in the small school where children's scores improved by over 45% on average. Overall, the difference between the pre- and post- Lesson Study score for the average child involved in the study was 2.2 scores out of a possible 6 scores. This shows an average improvement of 37.2% in children's reasoning skills following their teacher's participation in Lesson Study. A full breakdown of assessment scores by school and overall can be found in Appendix 4.

Statistical analysis and testing were applied to the children's reasoning skills assessment scores. As before, three tests, namely the Paired Sample T-test, Cohen's D and Cronbach's Alpha was applied to this data to test for statistical significance, effect size and reliability respectively [see Appendix 5]. The overall paired sample t-test statistics show that the mean score (N=52) of children's reasoning skills pre-Lesson Study was 0.92 (SD = 1.10) compared with 3.15 (SD = 1.56) post-Lesson Study which demonstrates a statistically significant improvement in the children's reasoning skills, $t(51) = 13.07$, $p < .001$. Statistical testing of individual school scores shows that quantitative differences between the school are not statistically meaningful (small school, n=10; medium school, n=24; large school, n=18), however they have been included in Appendix 5 for descriptive purposes. The effect size of the difference between the overall scores pre- and post-Lesson Study was d = 1.65, indicating a large effect size and strong difference. Of note, in comparison with the scales for Place Value, this effect size shows a larger difference in the Reasoning scores between the pre-test and the post-test. As before, analysis of individual school scores are not statistically meaningful owing to the small sample sizes involved, however they do provide an indication of school differences and the individual school effect on the overall differences. As evidenced in Appendix 5, the average pre- and post- Lesson Study reasoning skills assessments scores of children in each of the three schools show a strong difference, with the small school demonstrating the strongest difference of d=2.55 between the pre- and post- scores. Finally, reliability testing showed that whilst the scores have statistical significance, the pre-Lesson Study reasoning skills scale had a low reliability (α = .55) as did the post-Lesson Study scale (α = .53), owing to the fact that there were only three assessment items tested.

In addition to investigating the strength of children's reasoning skills in responding to the open-ended questions posed by teachers in the teacher/student interview, children's responses were also coded and analysed to investigate the types of responses that the children offered, see figure 17 below. To support the reader to interpret the figure, lower order thinking indicates where a child's response showed 'memorisation and/or understanding an idea without the reasoning process' was coded as a simple response [S]. Higher-order thinking indicates where a child's response showed either; (a) 'explaining, applying, analysing, evaluating' was coded as an explanation response [E] or (b) 'justifying one's own ideas' was coded as self-evaluation of one's own idea response [SE].

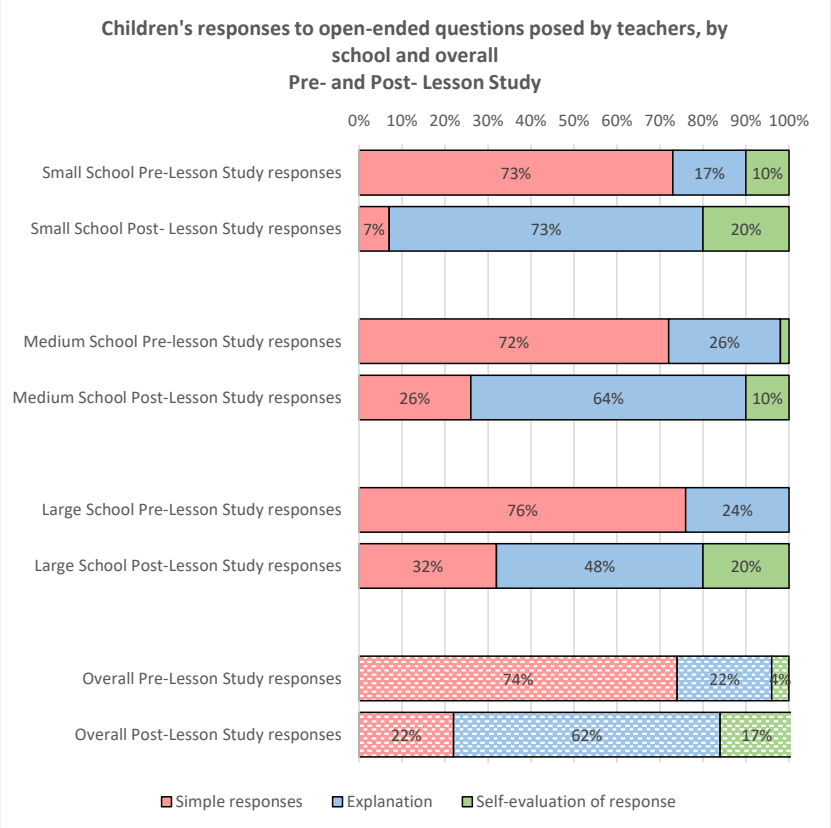


Figure 17. Analysis of children's responses to open-ended questions

Note: Total number of responses for small school is 30, for medium school is 72 and for large school is 54. Data labels for percentages of less than 3% were not included in this graph.

As evidence in figure 17, pre-Lesson Study measures show that three quarters of children's responses, across all schools, were categorised as 'simple responses' (74%). Analysis of pre-Lesson Study responses showed that higher-order responses accounted for approximately one quarter of responses (26%), most of which were explanations (22%) rather than self-evaluation of responses (4%). In comparison with the responses provided in the post-Lesson Study interview with teachers, there was a marked 52% decrease in the average proportion of simple responses offered by the children (from 74% to 22%), and conversely an average increase of 53% in higher order responses (from 79% to 26%). Further analysis of the comparable differences across each of the coded response categories also showed that there was a proportionally positive 13% increase in children self-evaluating their own responses on average (from 4% to 17%). Moreover, there was a more proportionally positive 40% increase in children providing explanation responses on average (from 22% to 62%). Conversely, the average proportion of children offering simple responses offered by children to open-ended questions reduced almost threefold overall (from 74% to 22%). A breakdown of the average differences in children's responses to open-ended questions, as presented in figure 17, shows a similar trend across each of the three schools. Given that differences were not calculated on ordinal data, it was not possible to run statistical testing. As such, unlike previous measures, differences in children's responses pre- and post- Lesson Study do not hold statistical significance.

4.5 Evaluation of Theory of Action

The initial Theory of Action (ToA) designed in collaboration with the participants essentially outlined 'how' Lesson Study was implemented in the study [See sub-section 3.4.1 – Figure 4]. More comprehensively, it outlined from the participants perspective, the supports, partnerships and collaborations that ought to be in place; the conditions and resources necessary for Lesson Study to be of appropriate quality; and finally, agreed protocols for Lesson Study teams to work together. As well as giving a defined structure to the Lesson Study model design, the ToA also functioned to allow for greater consistency in terms of how Lesson Study was organised and conducted across the three schools or research sites. Importantly, the initial ToA provided a test model of Lesson Study which could be evaluated and refined based on the experiences of the participants directly involved. The findings draw on a SWOT analysis activity completed with participants at the end of the intervention

and also on discussions with participants about the context for implementation at a broader level.

The refined ToA reflects the amendments which teachers made to the initial model of implementation with a view to articulating how Lesson Study might work best, more generally, to support Irish teachers to enact the new primary mathematics curriculum. The methods used to handle this data are outlined in sub-section 3.5.7.

4.5.1 SWOT analysis of Lesson Study as a professional development model

In the following table, the key findings from a SWOT activity conducted with participants, which examined their summative analysis of the test model of Lesson Study implemented in the study are recapitulated. The methods used to handle this data is outlined in sub-section 3.5.5 and summarised in table 16.

Table 30. SWOT analysis of Lesson Study

SWOT analysis of Lesson Study as a model of PD to support the enactment of the new primary mathematics curriculum	
Strengths	**Concerns**
Fosters mutual respect, trust, sharing and collegiality, cohesion and collaboration Promotes teacher autonomy, collective efficacy, teachers as researchers and reflective practice Cyclical and continuous PD rather than isolated events Practical, focused, context specific, and targeted to needs of the school Enjoyable, informative and child-centred process	Potential for insufficient time allocation to engage in Lesson Study properly Additional demands on school management to organise logistics (cover classes) Potential parental apprehension Disruption to class routine for children with special educational needs
Opportunities	**Threats**
Inevitable curriculum in-service (funding and resources provision) Professional Development Service for Teachers (Ireland) – models of sustained support	School culture – teacher readiness, resistance to change, reluctance; and managing misconceptions and expectations Lack of training for school leaders

Teachers agency and child's voice DES (Department of Education and Skills) policies - Cosán Framework for Teacher Learning (Teaching Council, 2016), Droichead (Teaching Council, 2017) School Self-evaluation (DES, 2016)	Insufficient funding or substitute cover Increasing demands on schools Standardised testing, textbooks and inconsistencies with Inspectorate model

4.5.2 Proposed context for implementing Lesson Study in Irish primary schools

Given that a primary aim of addressing the research questions in this study is to produce empirical findings to inform curriculum reform policy and practice, it was an added imperative of the research study to determine, from teachers' perspectives, favourable contexts for the implementation of Lesson Study in Irish schools. According to all teachers participating in the study, the most suitable setting for Lesson Study is in-school (school-based), where teachers can work in teams, with other teachers instructing at a similar class level. For small schools with multiple classes (for e.g., schools with four class teachers or less), it was suggested that clustering with other small schools would better allow for collaborative learning. Most teachers agreed that focusing on a single class or classroom group and working collaboratively on an agreed focus or aim of mutual interest to all teachers was optimal. Moreover, the teachers agreed that having Lesson Study facilitated by a mentor or Knowledgeable Other on-site, with additional remote access to facilitator and online support, would be most beneficial to teachers in supporting them to enact the new primary mathematics curriculum.

In terms of when Lesson Study would take place, all participants agreed that October to May were most suitable for conducting Lesson Study in schools. Many teachers suggested that a full day of induction and planning was appropriate to allow teachers to familiarise themselves with the process. Teachers in the small school expressed that for non-clustering schools, the opportunity to meet with other teachers would be a significant addition to their PD experience and suggested that this single induction and planning day could be held in a central location such as the local Education Centre. Thereafter, cycles of Lesson Study ought to be conducted in-school, with three suggestions for managing this process provided. Firstly, the participants proposed that schools could close for three full days and invite children from research classes to come to school for Research Lesson periods. Secondly, schools could remain open and utilise substitute cover to facilitate small groups of teachers to conduct Lesson Study on alternative days. Teachers did caution however that this option would require substantial logistical planning and could make it more difficult to

have mentoring support or Knowledgeable Others present on-site for planning and de-briefing phases of the Lesson Study cycle. Thirdly and most preferably, given the reduced disruption to parents and children, schools could close for six half days, inviting the research classes to remain for the Research Lesson.

Finally, participants strongly requested that sustained support also be considered as part of the implementation plan or model, particularly given past experiences of curriculum reform. This sustained support could be offered to schools onsite, possibly during Croke Park hours or online through a shared teacher space, or by other means of technological support such as email or blog support.

4.5.3 Refined Theory of Action

In refining the ToA, participants made a number of suggestions for improving and adjusting the test model of Lesson Study implemented in the study. Teachers expressed a wish for more access to a Knowledgeable Other or facilitator outside of structured Lesson Study times. The suggestion was put forward that a link communicator for each school could liaise on behalf of the school. Moreover, an online forum where teachers or link communicators could post questions and comments or receive updates was noted as another potential enhancement to the Lesson Study model.

A number of additional ecological supports for implementing Lesson Study were explored with participants. At a macro level, teachers suggested using Croke Park hours to conduct Lesson Study planning sessions, to avoid disruption to classes or the running of the school. At a micro level, conversation structures or prompts were proposed as useful to facilitate teachers to self-manage their own meetings and professional conversations. Participants suggested that in addition to the facilitator traits cited in the initial ToA, these traits should also include flexibility, adaptability, affability, non-authorities, knowledgeable, empathetic, resilient and experience teaching across a range of classes. Moreover, participants held that protocols for implementation ought to include joint ownership and collective responsibility of the teachers; agreed focus of professional conversations should be on the children's learning; and for teachers to be prepared to take risks and adapt when needed. Finally, participants expressed a preference for more background research to support curriculum changes to be added to the teacher toolkit, as well as lists of useful websites

Guiding questions for refining the ToA are summarised in table 17 [See sub-section 3.5.6] and the methods used to handle the data in refining the programme theory are outlined in

sub-section 3.5.7. The refined ToA is outlined in the next figure and reflects the suggested amendments and additions to the initial ToA tested in the study.

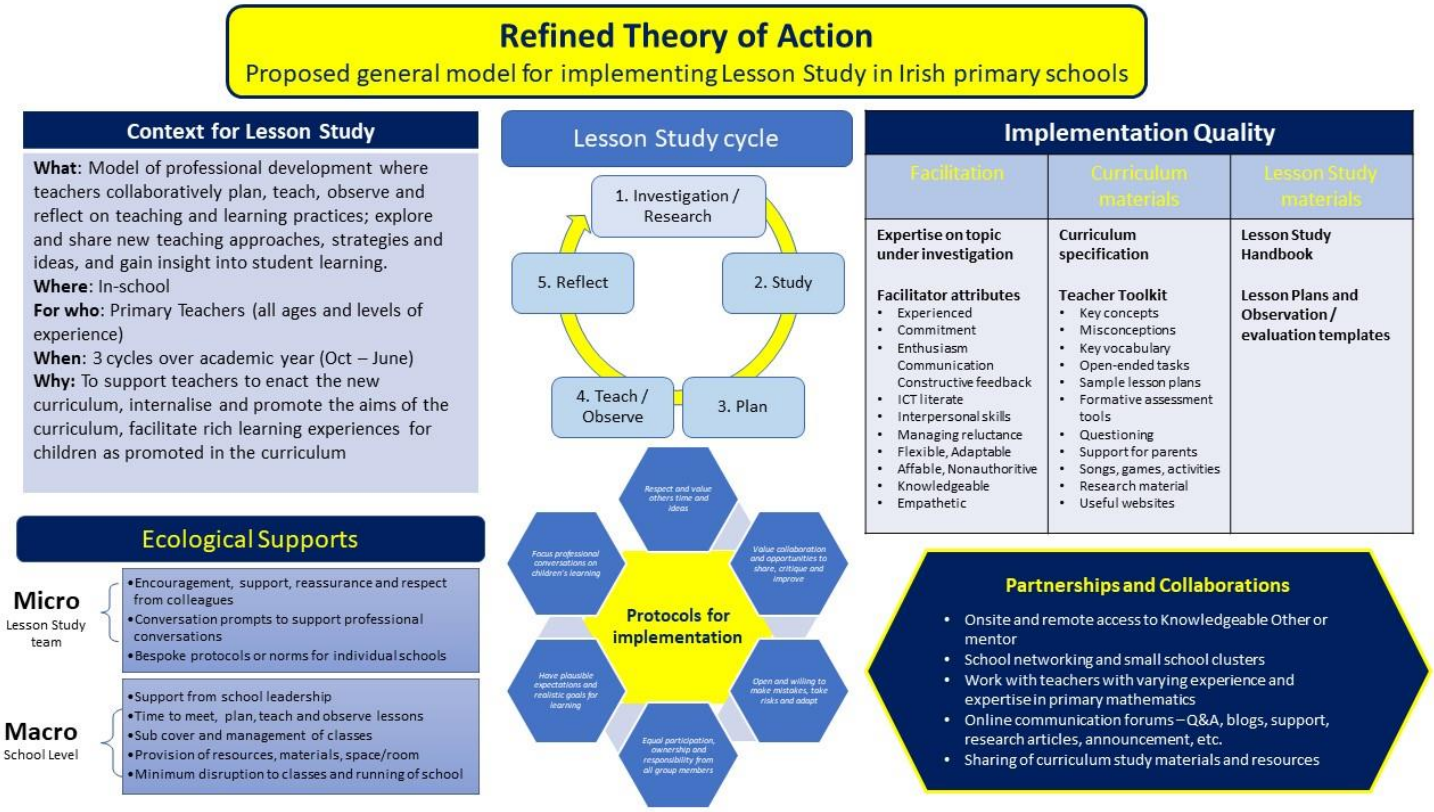


Figure 18. Refined Theory of Action – Proposed general model for implementing Lesson Study in Irish primary school

4.6 Summative evaluation of Lesson Study experience

In addition to evaluating the Lesson Study model using the programme theory framework (ToA), data on teacher's summative evaluation of their experience of engaging with Lesson Study was also collected. Findings refer to individual teacher testimonials of their experience with, and evaluation of, Lesson Study. The methods used to handle this data are outlined in sub-section 3.5.5 and summarised in table 16.

4.6.1 Individual teacher testimonials of experience with Lesson Study

Given that evaluation data in this study was predominantly collected in group interviews and focus groups during Lesson Study team meetings and full cohort meetings; much of the findings reflect collective views, ratings and feedback from the respective Lesson Study teams. In order to give the participants an opportunity to give individual feedback on their subjective experience, and thus mitigate against potential group bias, teachers completed individual testimonials of their overall experience with Lesson Study. These individual testimonials can be found in Appendix 7[20].

The findings from these individual teacher testimonials echo strongly the findings generated in the evaluation of the programme theory (ToA/ToC) and other summative reflections shared by the participants in group situations. Drawing on teacher's individual testimonials, many teachers reported a positive experience with Lesson Study describing it as enjoyable, informative, affirming, enriching, and interesting. Selena characterised Lesson Study as valuable and quality PD. The aspects of Lesson Study noted as most effective overall was the space it provided, opportunities to share constructive feedback, working collaboratively with colleagues, opportunities to observe lessons and engage in professional discussions, and the sharing of ideas among colleagues. In terms of positive outcomes for their professional practice, some teachers attested to being more open to collaboration, to "observing and being observed" (Lorraine). Leah described becoming more of a facilitator of children's learning, whereas Megan said it "opened up her approach to teaching".

Where teachers had a more negative experience with Lesson Study, this was largely attributed to being anxious to teach in front of other teachers; difficulties in marrying opposing ideas of teaching, learning and assessment; and too much time being afforded to

[20] Individual teacher testimonials are presented in tandem with the initial surveys conducted by the teachers at the beginning of study.

one curriculum topic, particularly as teachers are already "time poor" (Lorraine). Furthermore, teachers expressed concerns about the sustainability of Lesson Study and the allocation of necessary release time from the classroom "to do it [Lesson Study] properly" (Maria), the extent to which it relies on support from the school community. Teachers in the large school, expressed specific concerns about managing conflicting ideas and opinions; apprehensions around lesson observations; and the time invested in the process.

4.6.2 Attitudes to engaging with Lesson Study

To capture participants' overall experience with Lesson Study and determine how this may have changed or evolved over the period, the teachers were asked to select a word to describe their experience of Lesson Study, both before and after the intervention took place in their school. The following figure outlines the words selected by the participants. These words substantiate the individual testimonies provided by participants. Before the Lesson Study intervention took place in their school, participants described feeling apprehension, uncertainty and scepticism. Following the intervention, participants descriptions of their experience were more positive and hopeful, with chosen words depicting confidence, empowerment and openness.

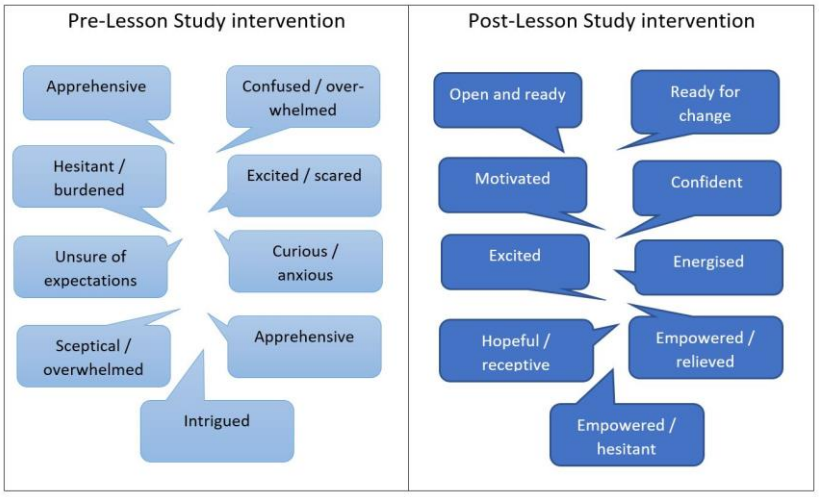


Figure 19. Participants' reflections on Lesson Study experience 'in a word'

4.7 Summative evaluation of theory-driven evaluation process

Given that TDE is a novel approach to curriculum enactment evaluation which the participating teachers identified as completely new to them, it was of interest to the study, albeit at a less critical level, to explore teachers' summative views and evaluation of the TDE process. The methods used to handle the data are outlined in sub-section 3.5.6.

4.7.1 SWOT analysis of theory-driven evaluation

The researcher facilitated a SWOT analysis activity with participants, to investigate their experience with the theory-driven evaluation (TDE) approach adopted in the evaluation of Lesson Study. Teachers were asked to agree the strengths of the TDE approach used in this research study and weaknesses about this approach, real or potential. Moreover, teachers were asked to note external opportunities and threats to using such an approach for evaluating curriculum PD in-service and enactment. In the following table, the key findings from this activity are recapitulated.

Table 31. SWOT analysis of Theory-Driven Evaluation (TDE)

SWOT analysis of Theory-Driven Evaluation (TDE) as a model of evaluation for curriculum in-service and enactment	
Strengths	**Weaknesses**
Bespoke evaluation that addresses the areas for development targeted by the individual school or schools The process is non-threatening, personal, flexible, practical and promotes confidence Fosters collective efficacy and ownership of successes and failures of the intervention Professional learning is constructive and can actually be used to inform school improvement planning Teachers more likely to take risks in the knowledge that they are not being evaluated externally	Non-standardised rigour could be questionable in the absence of national standards or comparisons to other teachers/schools Teachers do not know what they do not know and may hold misconceptions that are not addressed Potentially insular process that lacks insight Highlighting concerns of school seen as a weakness Lack of school leadership and teacher confidence

TDE is continuous – a formative rather than summative evaluation Leading and changing the school from within, by the people who know the school best Promotes reflective practice	
Opportunities	**Threats**
Consistency with current educational policy trends which promote school/teacher agency and autonomy Increasing familiarity in schools for self-evaluation and improvement planning	School culture – teacher readiness, resistance to change, reluctance; and managing misconceptions and expectations Lack of training for school leaders Insufficient allocation of time Increasing demands on schools inconsistencies with Inspectorate model

4.7.2 Stakeholder input as a core feature of curriculum evaluation

On the final data collection day, participants were asked about their experience of evaluating Lesson Study using the methodology adopted in the study (TDE), particularly given that their self-designed programme theory was central to the evaluation framework. Teachers expressed that they were appreciative of being involved so much in the evaluation process, with one teacher (Sandra) stating

> *"In schools you have inspectors coming in to tell you what they think of[curriculum] implementation in your school but how could they possibly know by looking at a few lessons. We've read reviews about implementation in our school and honestly, they're too generic to be of any use to us. We don't need someone from outside coming in and telling us, we know our school and our children best. There's no trust in teachers anymore, to the point where I think we barely trust ourselves. It was nice to be involved in evaluating it [Lesson Study] ourselves".*

Many of the participating teachers concurred with this viewpoint and suggested that future PD models which attend new curriculum reforms ought to incorporate a similar approach of involving stakeholder input in the evaluation of curriculum enactment. Notwithstanding,

the teachers felt that although useful, managing a TDE of curriculum enactment in schools would likely be difficult to manage. Participants did however suggest a simplified version of the evaluation framework which they believed would be more favourable to teachers which would explicitly state how the model should work in their school, what outcomes would be necessary to deem that Lesson Study was successful in supporting them to enact the curriculum; and introduce methods for monitoring and measuring success of enactment in the context of their schools. This approach, it was suggested, would complement the school improvement planning (DES, 2011) and School Self-Evaluation (DES, 2016) process already taking place in schools currently.

4.8 Conclusion of findings

In this chapter, two key strands and four sub-strands of evaluation findings were presented to address the central research question - Is Lesson Study an effective model of PD to support the enactment of the new primary mathematics curriculum?

In evaluating the ToC, the study was able to determine that the anticipated outcomes were largely achieved and, as such, it could be asserted that Lesson Study produced the outcomes implicitly assumed by the teachers to be necessary to enact the new primary mathematics curriculum. Notwithstanding, the study revealed and made explicit a number of additional unanticipated outcomes at each level of evaluation, which resulted in a more accurate and refined programme theory as to how and why Lesson Study supports teachers to enact the new curriculum. Moreover, the evaluation of the ToA and analysis of determinants and causal attribution at each level of evaluation served to explicitly reveal the key intervening contextual variables at play and in doing so, provide an explanation as to how and why Lesson Study produced these outcomes.

Given the scope of the study and the increasing complexity of gathering data at each successive level of evaluation (Guskey, 2000), objective measures of isolated outcomes at Level 4 and 5 were triangulated to investigate potential divergences with self-reported data gathered from participants, which looked at the impact of Lesson Study on teachers' practice and children's learning outcomes. Findings from these measures provide substantive and comparative validation of the self-report findings of the impact of Lesson Study at Level 4 and 5 (Guskey, 2000). To illustrate, while analysis of pre- and post- Lesson Study assessment results of children's learning affirmed the statistical significance of the

intervention for children's learning in Place Value and adaptive reasoning, the Level 5 outcomes observed in the Research Lessons and reported by teachers, serve to give additional meaning and educational significance to the changes and improvements in children's learning.

Commented [TC7]: Correction 4

Finally, summative evaluation data findings offered an additional layer of insight into the participants experience with and views of Lesson Study, and the process of theory-driven evaluation. Moreover, these findings served to elucidate the extent to which Lesson Study may be regarded as a catalyst for change and also highlight the aspects of Lesson Study which were most critical to successfully support the enactment of the new primary mathematics curriculum.

Importantly, the refined programme theory that was generated as an output of the research reflects the real-life experiences and honest views of the teachers who participated in the study. Taking the findings as a collective body of evidence, a number of assertions and claims can be deduced which address the key research question 'Is Lesson Study an effective model of PD to support teachers to enact the new primary mathematics curriculum?'. Key themes from the findings will be summarised and discussed in the next chapter. Points of discussion will be organised so as to speak to the embedded research questions and aims of the study established from the outset.

Chapter 5. Discussion

To address the research aim and gather the kinds of insights which are considered of most use to policy and decision makers (Pawson and Tilley, 1997; Guskey and Yoon, 2009) and towards bridging the gap between intended and enacted curriculum (Sahlberg, 2009), a theory-driven evaluation (TDE) of Lesson Study was conducted. A theory-driven approach to evaluation enabled the researcher to generate a programme theory which made explicit the teachers' assumptions as to how, why, and the different ways that Lesson Study ought to work to be considered successful in supporting them to enact the new primary mathematics curriculum. Guskey's five critical levels of PD evaluation (2000) was employed as a conceptual framework for designing and evaluating the ToC [See sub-section 3.5.3]. Summative data was also collected to supplement findings as to the overall merit of Lesson Study in supporting curriculum enactment. Additionally, objective measures of the impact of Lesson Study on teachers' practice and children's learning outcomes were taken to offer a greater level of robustness to the largely self-reported findings. This chapter will endeavour to synthesise the overall findings in the context of extant literature and research to address the three over-arching research questions

- Did Lesson Study work, and in what ways? [Section 5.1]
- How did it work, for whom and in what conditions? [Section 5.2]
- Why did Lesson Study work, what were the mediating factors or determinants at play? [Section 5.3].

These questions will be addressed individually in sections 5.1, 5.2 and 5.3 respectively. Within each section, key themes which emerged in the findings will be discussed in the subsequent sub-sections.

5.1 Did it work and if so, in what ways?

Commented [TC8]: Correction 6 – see re-order of subsections 5.1.1, 5.1.2, 5.1.3

Determining if Lesson Study was solely responsible for curriculum enactment and change in the context of this study is impossible, particularly given the complexity and mass of intervening variables at play in real-world settings such as schools (Guskey and Sparks, 1996; Guskey, 1997). Notwithstanding, it was feasible to generate evidence in this study to determine if Lesson Study contributed to outcomes found in the study (Guskey and Yoon, 2009). To determine if Lesson Study had 'worked' in this sense and in what ways, if any, it

had been successful in supporting teachers to make appropriate curriculum change, three strands of evaluation were conducted. Firstly, the teachers rated the extent to which anticipated outcomes had been achieved in actuality; and also provided qualitative insights into the ways that Lesson Study had, and had not, successfully supported them to enact the new primary mathematics curriculum. Secondly, summative data was collected on teachers' views as to the overall merit and impact of Lesson Study on their enactment of the new curriculum. Finally, to add robustness to the findings and mitigate against concerns about the reliability (Muckler and Seven, 1992), accuracy and validity of self-report data (Koziol and Burns, 1986), objective measures (i.e. non self-report) were taken of the impact of Lesson Study on specific aspects of teachers' practice and children's learning.

While there were some slight divergences in individual teachers' reported experiences with Lesson Study, taken as a whole, the vast majority of outcomes anticipated by teachers as being indicative of successful curriculum enactment were found to have been achieved in the study. Reported unanticipated outcomes from their engagement in Lesson Study were discovered which offered further substantive evidence of Lesson Studies merit within this context, as did summative feedback data. Moreover, the findings from objective measures (non-self-report) of outcomes on teachers' practice (teacher questioning) and children's learning (understanding of Place Value and adaptive reasoning skills) further served to assert the proposition that Lesson Study was successful in supporting teachers to enact the new primary mathematics curriculum in the three case study schools. In pragmatist terms given that what teachers predicted ought to happen, for the most part, did happen to a good (or very good) extent, then it is true enough or reasonable to assert that Lesson Study did work to support the participating teachers to enact the new primary mathematics curriculum. In the following sub-sections, the ways in which Lesson Study worked, or not, are discussed.

5.1.1 Meeting the demands of the new curriculum reform

Familiarity with changes to the curriculum

Lesson Study was found to support the participants to become more familiar with the new curriculum [See sub-section 4.2.2]. In particular, engaging in three cycles of Lesson Study was reported by the teaches in this study to provide them with valued time and space to familiarise themselves with new curriculum messages, the provision of which is considered

essential to successful reform efforts (Remillard, 2000). Lesson Study also served to illuminate for teachers a number of key inherent differences between the new and current curriculum: such as their role as teachers in enacting the curriculum and the role of the child in constructing and acquiring knowledge.

The teachers' understanding of the differences inherent in the new curriculum was largely attributed to the facilitated support and guidance provided by the Knowledgeable Other and facilitator (researcher). The self-report findings suggest that facilitated support and guidance offered the teachers clear, accurate and consistent messages about the new curriculum (Takahashi, 2014a). Fullan (1996) and Gersten et al. (2014) assert that this kind of messaging serves to illuminate the implications of new curriculum for teaching and learning in the classroom. Given teachers reported satisfaction with the Lesson Study experience, it holds that the consistency and thoroughness of these messages also likely contributed to their acceptance and adoption of the new curriculum (DES, 2005).

As similarly reported by Garet et al. (2001), Lesson Study was found in the study to provide scaffolded opportunities for teachers to focus specifically on new and unfamiliar aspects of the curriculum. In this case, children's understanding of Place Value (a curriculum topic not explicitly taught to senior infant children[21] at present); and the development of children's adaptive reasoning. These two aspects of the new primary mathematics curriculum were selected as the focus for curriculum study and analysis, known within the tradition of Lesson Study as *kyouzai kenkyuu*. Such opportunities to study new curricula are not typical of traditional PD models for Irish primary teachers and the participating teachers were found to respond particularly well to this opportunity, describing how being positioned in a researcher role had challenged and refined the way they thought about curriculum, a finding also reported by Elliott (2017). For the most part, participating teachers reported feeling more comfortable and confident with the new curriculum, albeit to a lesser extent for the teachers in the large school. Relatedly, analysis of the wider findings showed that teachers in the small and medium school also reported greater increases in sharing and collaboration among their peers as a result of engaging in Lesson Study than their large school colleagues. Given the link established by Lewis et al. (2009) between the development of a sense of community among teachers and their perceptions of new

[21] Senior infants is the second year of primary schooling in Ireland. Children are typically 5-6 years of age starting senior infants.

curriculum as more manageable, this may account for differences found in teachers comfort with, and confidence to use, the new curriculum [See sub-section 4.2.1].

New perspectives on curriculum enactment

As forecast by Lewis and Hurd (2011), Lesson Study was found to afford the teachers in the study opportunities to collaborate, share and discuss their interpretations of the new curriculum, and the subsequent implications for teaching the curriculum in practice. Most participating teachers reported that Lesson Study had challenged them to reconsider and refine how they use curriculum. This was particularly evident in relation to Curriculum Learning Outcomes, a new component of the primary mathematics curriculum that teachers were relatively unfamiliar with at the time of evaluation [See sub-section 4.2.2].

A key strength of Lesson Study reported by teachers was that it engendered new perspectives on curriculum enactment, and also afforded them autonomy and a deeper level of trust in their own decision-making and professional judgement to enact the curriculum. In particular, direct observations of progress in children's learning was attributed strongly to the teachers' renewed appreciation for their own sense of efficacy and professional judgement. Wood et al. (2017) advise that using such PD strategies can shift teachers' perspectives from a transmission-oriented to a construction-oriented view of teaching, and are a particularly useful means of helping teachers align with the perpetual demands of new curriculum.

Teachers reported that in contrast to how they had traditionally used the curriculum, they found themselves relying more on their knowledge and experience of teaching mathematics than the curriculum itself to enact the new Learning Outcome selected (Place Value). This raises questions as to whether more experienced teachers might be at an advantage in terms of gleaning the benefits which Lesson Study offers, given that they have more teaching experience to draw from. Given that teachers participating in the study had a wide spread of teaching experience, this was not self-evidently the case. According to Coenders and Verhoef (2019), in terms of professional learning at least beginning teachers participating in Lesson Study have an advantage as they do not have to unlearn established teaching repertoire or contend with reverting to old habits. On consideration of these views, it may be the case that while teaching experience was a benefit to enacting Learning Outcomes in the curriculum, it may be that this experience can sometimes hinder the process of change in alignment with new curriculum demands.

Professionalism and teachers as 'enactors of curriculum'.

Teachers participating in the study lauded the time and space which Lesson Study afforded them to reflect on teaching and learning with the new curriculum. As similarly found by Darling-Hammond and McLaughlin (1995), this time and space provided teachers with dedicated opportunities to learn how to work together, to question and analyse change in a way that was deeply relevant to their own (local) teaching contexts. Many teachers in the study reported that through the process of discussion, collaboration and reflection they had changed how they thought about themselves as professionals and their role in teaching the new curriculum. By providing a space for teachers to work and develop professionally in collaboration with their peers, and capitalise on the collective expertise and strengths of fellow Lesson Study team members; Lesson Study was found in this study to provide a model of PD, which Fullan and Hargreaves (2016) suggest holds the most promise in mobilising and orienting teachers towards contemporary policy aspirations.

Interestingly, despite the provision of a suite of curriculum support materials that were intended to offer supplementary guidance and support for teaching the selected Curriculum Learning Outcome (for Place Value), teachers consistently rated these support materials as having little or no responsibility for the positive impact they experienced with Lesson Study and their enactment of the curriculum. Rather, teachers attributed this positive impact to opportunities they were afforded to work collaboratively with their peers, to share and reflect on ideas, and to observe and analyse children's learning. In doing so Lesson Study was found to provide what Rué (2016) similarly found, a co-operative means to enhance professionalism and hone teachers' sense of craftmanship in enacting the new curriculum.

Directly addressing the issues raised by Murchan et al. (2009), it was found that teachers' enactment of the new primary mathematics curriculum in Research Lessons was rather largely a result of them working autonomously and collaboratively in their in-school teams, and using the children's learning (understandings and misunderstandings) as the impetus for professional learning and practice. Given that the new primary mathematics curriculum is a Learning Outcomes based curriculum with a much-reduced specification to the current curriculum (NCCA, 2017), which requires teachers to increasingly draw upon their professional autonomy, decision-making and judgement (NCCA, 2016b), these findings are encouraging of the merit of Lesson Study to support curriculum enactment, in this case.

Negotiating [curriculum] change through the process of Lesson Study

In Fan Yang's (2013) investigation into the use of Lesson Study to support curriculum reform efforts in China, Lesson Study was found to help teachers to negotiate change by providing a space where the teachers could make explicit their implicit thoughts, beliefs and assumptions about the reform. It was observed that by engaging in the Lesson Study process, the participating teachers' awareness was drawn to their theories and beliefs about how best to teach and learn mathematics [See sub-section 4.2.4]. To exemplify, early in this study, teachers in the large school Lesson Study team expressed initial frustrations with sharing the lesson planning and decision-making process with their colleagues. They also reported challenges in managing conflicting ideas and opinions as to what tasks, questions and ideas to use in their first Research Lesson. Reported tensions among this Lesson Study team largely eased as Lesson Study cycles progressed and teachers described becoming increasingly comfortable with a more collaborative and shared decision-making process. Pajares (1992) holds that when justifiably challenged, teachers' existing beliefs can be refined and can assimilate new ideas and practice can be assimilated. In providing space in which to challenge existing ideas and belief, it is thus plausible that Lesson Study helped to mitigate against the negative effects of deeply held unconscious beliefs and practices (Mayrhofer, 2019) and in doing so, served to catalyse curriculum change in a timely and meaningful way.

Fan Yang's (2013) study also showed that teachers mediated and managed external reforms by using their own native concepts to understand and express their understanding of the reforms. Similarly, in this study, when participating teachers were observed to collaborate effectively during the Lesson Study cycles, they developed a shared language to talk about their learning, for example in their common description and characterisation of 'teachable moments' [See sub-section 5.1.2 – Subject matter knowledge). Moreover, they developed a shared repertoire of strategies to enact the curriculum in practice, for example managing and responding to mistakes, and use of questioning to develop reasoning [See sub-section 5.1.2 - Curriculum in practice). In alignment with Corcoran's (2010) conjectures as to how Lesson Study builds teachers' capacity (and translates into more successful teaching of mathematics), there is an intuitive link between the collaborative process engendered by Lesson Study and the reported ways that Lesson Study was found to support teachers to negotiate the meaning and implications of curriculum change in terms of their own practice.

Teachers in the small and medium schools lauded Lesson Study as supporting them to negotiate curriculum change for their own context (school and classroom) to a very great extent. These teachers made particular reference to the learning gleaned from observations of the curriculum enacted in the Research Lessons and the discussions, sharing and reflecting that ensued in the post-Research Lesson discussions. The cyclical nature of Lesson Study and the iterative process of planning, teaching and assessing learning in the Research Lessons was found to provide a transformative space where the teachers could try out aspects of the curriculum in practice, with little perceived risk [See sub-section 4.2.5 – Unanticipated outcomes]; and hone their enactment of their curriculum through engaging and collaborating with their colleagues and refining their practice over time. Whilst still relatively positive about Lesson Study, teachers in the large school were less satisfied with Lesson Study, particularly in terms of its use of their time, which they perceived as primarily addressing only one topic of the curriculum, leaving little or no time to look at other content areas of the curriculum. According to Ermeling (2010) the product of Lesson Study is less important than the process of teachers collaborating and conversing with one another on curriculum and pedagogy. In the absence of this understanding of Lesson Study, it is possible that these teachers were less impressed by the outcomes of Lesson Study in terms of its role in supporting them to enact the curriculum. Moreover, this finding highlights the importance of addressing teachers' perceptions, misconceptions and expectations about Lesson Study and making clear the importance of the process that Lesson Study enables from the outset.

Analysis of the emotional responses of teachers to engaging with Lesson Study pre- and post-intervention showed a significant shift in teachers' attitudes and motivation over the period [See sub-section 4.6.2]. Participants' feelings of apprehension, uncertainty and anxiety were replaced with expressions of confidence, receptiveness, openness and empowerment. Whilst these responses spoke directly to the teachers views of Lesson Study, this shift is indicative of the changes required for teachers to embrace and enact curriculum reforms (Evans 1996; Wallace and Priestley, 2011; Hargreaves and Fullan 2012; King, 2014). The participating teachers also collectively reported that Lesson Study offered them more ownership and control over their management of the curriculum and their PD. Given that a DES curriculum implementation evaluation report (DES, 2005) found that the schools who were most successful in enacting curriculum in their schools had taken ownership of the process and did not rely on external support services to mediate the

curriculum, this is an additional finding indicative of the potential Lesson Study holds as a model of PD to support enactment of the new curriculum.

5.1.2 Knowledge for teaching and instructional practice

Across all three schools, Lesson Study teams agreed from the outset on two aspects of the new primary mathematics curriculum upon which to focus Lesson Study activities. Firstly, they elected to focus on supporting children towards achieving a Curriculum Learning Outcome for Place Value, a new learning topic for children in senior infants. Secondly, participants agreed to focus on supporting the development of children's adaptive reasoning[22], namely their capacity for logical thought, reflection, explanation, and justification (NRC, 2001; NCCA, 2017). The research findings demonstrate that Lesson Study enabled teachers to conduct an in-depth study of both of these selected areas, resulting in a number of anticipated and unanticipated enhancements to their teacher knowledge. Given that Irish teachers have explicitly welcomed guidance on developing their knowledge of new curriculum to support them in enacting curriculum in practice (INTO, 2015) and also Lewis et al.'s (2006) assertion that teacher knowledge is a key pathway to instructional improvement that is strengthened by Lesson Study; this is a promising finding in terms of Lesson Study's potential to support curriculum enactment in practice.

To establish the ways Lesson Study worked to support teachers to develop their knowledge for teaching (or enacting) the new mathematics curriculum, it is useful to discuss the salient findings in terms of subject matter knowledge and pedagogical content knowledge - two broad domains of Mathematical Knowledge for Teaching (MKT) delineated by Ball et al. (2008) that are considered important to support children's mathematical learning (Ma, 1999; Hill et al., 2005). In addition, the ways that Lesson Study impacted the participants classroom practice or instruction; specifically, their teaching style, use of questioning and their use of formative assessment is also discussed in the context of enacting the new curriculum.

[22] Adaptive reasoning is one of the five key aspects of mathematical proficiency, the development of which is the overarching aim of the new primary mathematics curriculum (NCCA, 2017).

Subject matter knowledge

As each Lesson Study cycle progressed, many participating teachers described cultivating a deeper understanding of Place Value as a mathematical topic, as well as developing a greater appreciation for how the curriculum topic (Place Value) was connected with, and foundational to, other areas of mathematical learning. As each Lesson Study cycle progressed, teachers were also found to increasingly identify, analyse and investigate the children's understandings, misunderstanding and misconceptions of Place Value. Furthermore, teachers were also observed to discuss children's learning of Place Value in post-Research Lesson discussions with increasingly levels of astuteness and perceptiveness.

In accordance with Lewis and Hurd (2011), the teachers then developed a common language to discuss these incidences in the Research Lessons, labelling them as 'teachable moments'. Furthermore, beyond the first Research Lesson, rather than referring to the curriculum document for guidance on planning subsequent Research Lessons, these teachable moments (or moments of unexpected insight) identified in the Research Lessons became the impetus for planning, teaching and assessment in future lessons. These insights and teachers increasing perceptiveness served to build on and deepen both the children's and the teachers' understanding of the [Place Value] topic. The teachers' use, or rather lack thereof, of the curriculum document was considered in light of Mynott's (2019) suggestion that Lesson Study may put limitations on teachers' learning. However, of note, the teachers in the study were also found to demonstrate autonomy outside of facilitated Lesson Study time, with one of the participating teachers even being reportedly inspired, to conduct their own further in-depth investigation of Place Value at home themselves.

Notably, a criticism often levelled at Curriculum Learning Outcomes is that the level of detail they provide is too vague, woolly or insufficient to specify what teachers ought to teach (Priestley, 2016). Notwithstanding the broad nature of Curriculum Learning Outcomes, teachers self-reported that specified outcomes anticipated for their subject-matter knowledge in teaching Place Value were achieved. These findings suggest that Lesson Study may hold potential to support teachers to negotiate and teach broad Curriculum Learning Outcomes, as evidenced in this study in the context of mathematics.

Pedagogical content knowledge

A criticism of the last primary curriculum reform in Ireland, in 1999, pointed to the tendency of the attendant PD (in-service) model to centre on equipping teachers to respond to curriculum change rather than on refining and developing pedagogical approaches and reflective practice (Harford, 2010). This might be explicable given that changing *how* mathematics is taught is considered far more challenging than changing *what* mathematics is taught (Takahashi and McDougal, 2016). As such, the impact of Lesson Study on teachers' pedagogical content knowledge was of particular interest in terms of supporting teachers to enact the new primary mathematics curriculum.

In Research Lessons, teachers reported positively on the use of cognitively challenging tasks, formative assessment and maths talk - key meta-practices integral to enacting the new primary mathematics curriculum (Dooley et al., 2014). In preparation for Research Lessons, teachers were observed to purposefully and strategically devise problems and tasks that required higher order thinking and reasoning. Whilst the selection of adaptive reasoning as a focus for Lesson Study activities undoubtedly influenced teachers' actions in this regard, it is also plausible that in doing so, teachers enhanced their understanding and use of mathematical tasks. This assertion is supported by established links between participation in Lesson Study and the development of higher-order mathematical tasks found in another study by Barber (2018). The participating teachers' propensity to use explicit strategies to promote maths talk in the Research Lesson was also observed to increase over the research period. Moreover, it was observed that maths talk predominantly took place between teachers and children initially, but this shifted increasingly to peer-to-peer discussions and dialogue as each cycle of Lesson Study progressed.

On evaluating the teachers' practice in the Research Lessons, participating teachers reported making knowledgeable and well-informed instructional choices when enacting the curriculum. By the third cycle of Lesson Study, Lesson Study teams were observed to make natural diversions in the pre-planned Research Lessons, particularly in response to the 'teachable moments' identified in the lessons. This finding holds particular significance in determining the merit of Lesson Study to support enactment of the new primary mathematics curriculum, as the teachers actions around these teachable moments translate closely to what Corcoran (2012) describes as contingency teaching. According to Corcoran (Ibid), this focus on and identification of unforeseen insights into children's

learning, and the subsequent response that teachers make to these insights is key to the development of children's mathematical proficiency, the core aim of the new primary mathematics curriculum.

In addition, the teachers evaluated positively the targeted use of questioning in Research Lessons, which they strongly attributed to improvements in children's reasoning and higher order thinking skills. Teachers reported that they strategically crafted and posed open-ended questions with a view to optimising the children's individual strengths and knowledge; and to address their misunderstandings and misconceptions on the topic (Place Value). Correspondingly, they associated their educated use of questioning with promoting a more inclusive learning experience. Looking at the findings as a whole, it could be argued that the teachers' increasing responsiveness to the children's misunderstandings and misconceptions, in turn, resulted in deepening their own mathematical knowledge and subsequently informing their instructional decision-making and contingent actions in practice.

Teachers strongly attributed the achievement of successful outcomes in terms of their pedagogical content knowledge to the opportunities which Lesson Study afforded them to have professional conversations around the Research Lesson, to analyse and evaluate the children responses to teaching activities and instruction, and to provide time and space to think about teaching and assessment ideas. In doing so, these elements of Lesson Study were found to support teachers to hone their "expertise for teaching" (Takahashi and McDougal, 2016, 516) as well as a number of the meta-practices proposed in background research reports and papers as essential to the enactment of the new primary mathematics curriculum (Dooley et al., 2014; Dunphy et al., 2014; NCCA, 2016a, NCCA, 2016b).

Curriculum in practice

A key observation reported from Research Lessons was the allocation of increasing waiting time to children to respond to teacher questions and discussion prompts. Many teachers reported that they developed a renewed appreciation for how important it was to give children space and time to think about, and struggle with, their mathematical ideas; and the benefits this had for the development of children's adaptive reasoning and higher order thinking skills. Teaching instruction was observably focused on eliciting and generating higher-order reasoning and thinking in the Research Lessons, largely evidenced from the quality and depth of the questions and tasks posed by the teachers. Intuitively, the teachers

were observed to adopt a less didactic role with each Lesson Study cycle, with teachers noticeably stepping back and allowing children to 'figure it out' for themselves, This was also evidenced from a recent study by Ní Shúilleabháin and Seery (2017); and corresponds with a less transmissive and more contemporary view of the teacher as professional (Kennedy, 2014).

Whilst not initially anticipated, a number of teachers expressed how engaging in Lesson Study led to them also rethinking and refining their teaching approach. One common way in which the teachers were observed to do so was by embracing mistakes and mathematical errors. Moreover, teachers reported offering more explicit time and space for children to think during maths lessons than was typical of their lessons prior to the introduction of Lesson Study. In making these adjustments and enhancements to their instructional practice, Lesson Study supported the teachers to rethink and adjust their teaching to better align with new curriculum aims (NCCA, 2017), epitomising what Little (2003) described as the decontextualization and recontextualization of curriculum reform.

Another indication of Lessons Study's influence on the teachers' instructional approach is the increasing precision with which they pitched their teaching to provide a more individualised learning experience for the children. Whilst not initially anticipated, teachers largely attributed this outcome to the assessment and observation data collected in the Research Lesson. Notwithstanding, it is plausible that the teachers' interpretation of this data was also enhanced by the teachers' increasing level of astuteness and sophistication in the use of open-ended questions and subsequent interpretation of children's understandings and misunderstandings [See sub-section 5.1.2 – Pedagogical content knowledge and Subject matter knowledge].

An unanticipated but decisive outcome reported by teachers from their engagement with Lesson Study was also a shift in the way that they thought about, understood, and ultimately used formative assessment in their maths lessons. Teachers reported how, as a result of engaging in Lesson Study, they reconceptualised formative assessment as asking intentional open-ended questions, being attentive to 'maths talk' and identifying what teachers called 'teachable moments' or deep insights of children's misunderstandings and misconceptions [See sub-section 4.2.2 – Unanticipated outcomes]. Evidence derived from these methods of formative assessment was subsequently observed to then be used to inform pedagogical decision-making and as the impetus for future lesson planning. By conceptualising and using formative assessment in this way, the teachers reported to

redirect teaching resources and instruction to allow for, as Kulasegaram and Rangachari (2018) similarly found, a more meaningful curriculum experience. Moreover, by helping teachers to become more attentive to children's learning, as described above, it suggests that Lesson Study contributed to teachers' instruction of the curriculum in a way that had mutual benefits for the teachers' and children's learning.

Use of questioning

Another way in which Lesson Study was found to work was in terms of teachers' enhanced use of questioning in maths lessons, in particular their increasing propensity to use open-ended questions to support the development of children's adaptive reasoning, to assess learning, and to elicit and extend the children's mathematical thinking. In evaluations of Research Lessons, the effective use of 'why' questions was particularly noted in this regard. Given the outcomes found in terms of the teachers' subject-matter knowledge [See sub-section 5.1.2 – Subject matter knowledge], it is reasonable to establish an intuitive link between the teachers' increasing astuteness and perceptiveness of children's level of understanding and misunderstanding of the curriculum topic, and their enhanced sophistication in formulating questions in their maths lessons. Notwithstanding a lack of literature to support the following claim, the participating teachers reported that by posing targeted and individualised open-ended questions, they were able to provide a more appropriate level of challenge to the children, and concomitantly, provide a greater level of inclusion and differentiation in the Research Lessons.

In addition to self-report data of teachers use of questioning, coded analysis of the kinds of questions posed by the teachers in their maths lesson, and quantitative measures of the proportion and frequency of open-ended questions posed were conducted [See sub-section 4.4.1]. A similar trend was found in terms of both the average proportion [See figure 13] and frequency [See figure 14] of open-ended questions posed across four evaluation points [See sub-section 4.4.1]. Recordings of maths lessons showed an increase in the average proportion of open-ended questions posed by teachers across the evaluation period (25% pre-Lesson Study; 53.1% in the Research Lesson; 58.6% one-month post-Lesson Study) before a relatively slight decrease of 55.8% (4-6 months post-Lesson Study). Correspondingly, the frequency of teachers use of open-ended questions increased in a similar trend (one open-ended question every – 2 minutes, 6 seconds pre-Lesson Study, 1 minute, 24 seconds in the Research Lesson; 1 minute, 3 second one-month post-Lesson

Study; 1 minute, 18 seconds 4-6 months post-Lesson Study). These findings serve to further substantiate Lesson Study's merit in supporting teachers to enact the new primary mathematics curriculum, particularly as changes largely sustained following the intervention. However, longitudinal studies of the impact of Lesson Study on teachers questioning would be needed to make a definitive assertion of this.

As previously found by Kim (2015), this study established a correlation between the development of children's reasoning skills and teachers' use of questioning. As aforementioned, this is likely linked to the participating teachers' focused and concentrated efforts to support the development of children's adaptive reasoning, however further research would be needed to establish this link definitively. The research suggested that participating in Lesson Study influenced teachers' practices, specifically, the types of questions posed by teachers in maths lessons. Analysis of the breakdown of question types posed by teachers [See figure 12] showed that the most notable change in teachers' use of questioning was in their proportional use of questions which asked for explanation. The teachers' use of these questions increased from 20.3% pre-Lesson Study, to 41.8% in the Research Lesson, further again to 47.6% one-month post-Lesson Study, before dropping relatively slightly to 45.1%. In a similar way, teacher's proportional use of questions which asked for self-evaluation of reasoning and self-evaluation of others' reasoning were found to follow a similar trend over the evaluation period, albeit to a lesser proportion.

5.1.3 Gains for children's learning

A core goal of curriculum is the development of children's learning and understanding, and the provision of appropriate and relevant experiences in which to learn. Naturally, the end goal of teacher PD is the same (Guskey, 2016). The impact of Lesson Study on children's learning is discussed herein, with due consideration of epistemological changes [See sub-section 2.3.4]; and aims, goals and specified Learning Outcomes in the new primary mathematics curriculum [See sub-section 2.4.7]. In drawing links between participating teachers' enactment of the curriculum through Lesson Study and relative gains in the children's learning, this discussion draws on teacher's observations of children's learning in the Research Lessons, teachers' summative reflections and objective measures of children's understanding of Place Value and adaptive reasoning skills.

Learning outcomes

The two curriculum areas selected and isolated as the focus for Lesson Study activities were largely unfamiliar to the children's frame of reference or classroom experience, particularly as Place Value is not taught in primary schools until 1st class (the year follow8ing senior infants) and adaptive reasoning is not an explicit aim of the current curriculum primary mathematics curriculum. As such, teachers would not previously have taught or be teaching Place Value to the cohort of children assessed in the study. Neither would these children have had explicit support to develop their adaptive reasoning previous to, or during the research period. As such, this serves to strengthen the credibility of evidence attributing Lesson Study to gains for children's learning (Guskey, 2002).

The synthesis of findings which show gains for children's learning as a result of their teachers participation in Lesson Study draw on evaluations of children's learning in the Research Lessons (against predetermined indicators of success) [See sub-section 4.2.5]; teachers' observation data; and summative feedback collected over the evaluation period. Analysis of these collective findings provide compelling evidence to suggest that in the three case schools, the children had experienced positive gains in learning outcomes. These gains include positive outcomes that were both anticipated by teachers, as well as a number of additional unanticipated outcomes. Furthermore, to triangulate the credibility of these self-report findings, objective measures of children's learning pre- and post-Lesson Study provide further substantive evidence of improvements to gains for children's learning, namely to children's understanding of Place Value and their adaptive reasoning skills. These findings are discussed in more detail below and can now be added to the growing body of evidence that links Lesson Study with improvements to children's learning (Lewis et al., 2006; Foster and Poppers, 2009; Lewis et al., 2009; Saunders et al., 2009; Perry and Lewis 2010; Waterman, 2011; Lewis and Perry, 2017).

Children's understanding of Place Value (Curriculum Learning Outcome)

Participating teachers' summative evaluations of Lesson Study concluded that the successful achievement or gains in children learning in Place Value were attributable to Lesson Study to a very great extent. Evidence of gains in children's understanding of Place Value further support this assertion [See 5.2.5 – Curriculum Learning Outcome for Place Value]. In particular, children in the study were observed to make explicit connections in their learning, recall previous learning and to build on their understanding from one

Research Lesson to the next. This was largely observed to emerge as a result of the sophisticated questions problems and tasks posed by the teachers. Children were also observed to make considerable gains in their use of communication and language to discuss and explain their thinking, ideas and understanding of Place Value. Teachers reported improvements in the children's vocabulary and verbalisations skills, in particular, a broader use of vocabulary and more sophistication in articulating their thinking, as a positive outcome from Lesson Study that they had not initially anticipated.

Improvements in children's use of communication and language was reportedly most evident when the children were provided with additional time; and opportunities to explore different ways of talking about and representing their understanding, as promoted in the new primary mathematics curriculum (NCCA, 2017). Given the evidence of reported gains in the children's communication and language over the research period, and correspondingly, findings from analysis of reported outcomes for teachers' knowledge for teaching and instructional practice; such as increased waiting time, effective use of questioning and promotion of maths talk [See sub-section 4.2.2 – Pedagogical content knowledge; Curriculum in practice]; these findings suggest that Lesson Study supported teachers to translate their interpretations of the new curriculum into their practice in a way that was meaningful and resulted in tangible improvements in children's learning.

Comparisons of pre- and post-Lesson Study assessments of Place Value show statistically significant improvements in children's understanding of Place Value against predefined criteria [See sub-section 4.4.2], with an average of 27.9% improvement in assessment scores. The greatest improvements in children's learning was found in the medium sized school, in fact the children in this school experienced an improvement that was on average three times greater than the children in the large school. Analysis of the findings shows no obvious rationale to explain the difference in learning outcomes for children in these two schools. Two distinguishable positive outcomes reported by teachers in the medium school which may account for this, is their reported relationships with their fellow colleagues and also unanticipatedly with the children in the research classes as a result of engaging in Lesson Study. Another intuitive link might be the link with reported increases in collegiality, and in sharing and collaboration [See sub-section 4.2.3].

Collectively, these findings suggest that the successful efforts made by teachers to deepen the children's understanding of Place Value was heavily informed and enriched through the Lesson Study activities which teachers engaged with in and around the Research Lesson

[See sub-section 5.1.2 – Subject matter knowledge]. Given that the teachers reported to provide children with a more differentiated and individualised learning experience [See sub-section 5.1.3 – Inclusive and differentiated learning], it is also probable that the children's learning of Place Value was appropriately accelerated and scaffolded to allow them to learn closer to their zone of proximal development (Vygotsky, 1978).

Children's adaptive reasoning (Curriculum Aim)

The development of children's adaptive reasoning - their ability to think, explain and justify their thinking and ideas in mathematics, was the second of the two key focus areas selected by teachers for the Lesson Study investigation. Observations and informal assessments of children's dialogue in Research Lessons indicate that when posed with open-ended problem-centric questions (in particular 'why' questions) and tasks, the children increasingly applied adaptive reasoning to provide explanations and justifications for their thinking [See sub-section 4.2.5 – Adaptive reasoning], a link also established by Kim (2015). In addition, children were reported to demonstrate increased confidence in responding to teachers' questions and also an increased proclivity or willingness to take risks and attempt tasks and problems with greater ease.

Comparisons of pre- and post-Lesson Study assessments of children's adaptive reasoning also show statistically significant improvements in the quality of children's reasoning skills, against predefined criteria [See sub-section 4.2.5 – Adaptive reasoning], with an average of 37.2% improvement in assessment scores. Notwithstanding the positive results in the small and medium schools, children in the small school made the greatest average improvement of 46.7%. Moreover, comparative analysis of the types of responses offered by children in the pre- and post- Lesson Study teacher/student interviews show consistent results across all research sites (schools), in particular reductions in their use of simple responses and conversely, an increase in their provision of explanations and self-evaluation when responding to open-ended questions. Observation data of children's learning across all research sites fortify these findings and illuminated shifts in children's observable behaviour as each Lesson Study cycle progressed - from initial reluctance to vocalise their thinking, to children demonstrating increased proclivity to explain and justify their thinking [See sub-section 4.2.5 – Adaptive reasoning].

There are a number of natural links which might be made between improvements in children's reasoning skills, such as the provision of additional waiting time and space to the

children [See sub-section 5.1.2 – Pedagogical content knowledge]. The shift in the classroom culture to embrace mistakes [See 5.2.2 -Teaching approach] may also have contributed to an increase in the children's confidence to demonstrate their adaptive reasoning. Notwithstanding these links, it remains difficult to attribute Lesson Study solely to improvements in children's reasoning skills. There are however a number of intuitive links that can be made between established outcomes in the teachers' knowledge and practice and gains in the children's adaptive reasoning, such as reported increases in waiting time and effective use of questioning [See sub-section 5.1.2 – Pedagogical content knowledge; Curriculum in practice]; the promotion of classroom culture that welcomes mistakes [See sub-section 5.1.3 – Learning experiences] and raised expectations of children's learning ability [See sub-section 5.1.3 – Inclusive and differentiated learning]. Moreover, whilst not explicitly noted by the teachers themselves, the researcher observed that considerable time was dedicated in post-Lesson Study discussions to discussing children's responses, which may also have contributed to the focus applied to this area of the children's development.

Summary of statistical analysis of learning outcome gains

To summarise the impact of Lesson Study on children's learning as objectively measured in this study, the following two tables are provided. Table 32 outlines the average differences in children's scores on pre- and post-Lesson Study assessments of Place Value and reasoning skills, by school and overall. A full breakdown of results can be found in Appendices 3 and 4.

Table 32. Average differences in children's learning pre- and post- Lesson Study

	PLACE VALUE Average % difference	**REASONING SKILLS Average % difference**
Small school (n=10)	**31.3%**	**46.7%**
Medium school (n=24)	**37.5%**	**34.7%**
Large schools (n=18)	**13.1%**	**35.2%**

Table 33 outlines the results of statistical testing applied to pre- and post- Lesson Study assessment of children's understanding of Value and their reasoning skills. For a full breakdown of results see Appendix 5.

Table 33. Summary of statistical testing results

Name of Test	**Place Value** results	**Reasoning skills** results
Paired Sample T-Test	**Statistically significant improvement** in the children's reasoning skills, $t(51) = 8.72$, $p < .001$	**Statistically significant improvement** in the children's reasoning skills, $t(51) = 13.07$, $p < .001$
Cohen's D	**Large Effect Size/Strong difference** d=1.14	**Large Effect Size/Strong difference** d=1.65
Cronbach's Alpha	**Low reliability** Pre- α = .47 Post- α = .57	**Low reliability** Pre- α = .55 Post- α = .53

Learning experiences

According to Franke et al. (1998), educational change is contingent on developing and refining teachers' epistemological perspectives of what it means to learn as well as their conceptions of learning. On reflecting on the impact of Lesson Study on teaching and learning, many of the participating teachers noted a shift in their conceptions of what quality mathematical learning for children looks like. In contrast to typical maths lessons, which teachers conceded tend to be largely textbook driven, the teachers equated quality learning in Lesson Study Research Lessons with simplicity and richness. Notably, it was remarked by teachers that not only were textbooks not required to enact the learning intentions established for the Research Lesson, but there was, in general, little observable use of resources evident across all cases. Rather, the teachers attributed the richness of children's learning experience in the Research Lessons to the quality of questions, tasks and problems devised by the team in the Lesson Study planning sessions. These characterisations and descriptions of the teaching and learning experience strongly reflect key meta-practices underpinning the new primary mathematics curriculum, such as the development of cognitively challenging tasks (Dooley et al., 2014; Dunphy et al., 2014). In doing so, the findings from this study also align with Lieberman's (2009) case study findings, to offer further indications of Lesson Study's credibility to translate intended curriculum into children's lived experiences.

When enacting the new primary mathematics in the Research Lessons, the teachers characterised the lessons as a space where children were afforded 'waiting time' and space

to think, talk, reflect and explain their thinking. More pointedly, teachers reported that owing to their own enhanced pedagogical content knowledge and the insights offered in 'teachable moments' [See sub-section 5.1.2], they found that the classroom culture became increasingly more conducive to children taking risks and making mistakes. These reports mirror findings from a recent study by Shingphachanh (2019) that found Lesson Study to be helpful in offering autonomy to children to explore their mathematical ideas. Moreover, teachers reported a renewed appreciation for the benefits of identifying children's misconceptions and mistakes, for both the teacher and the learner, as experienced in the Research Lessons [See sub-section 5.1.2 – Curriculum in practice]. Relatedly, in a cross-cultural analysis of Malaysian maths lessons (Arani et al., 2017), it was found that in a classroom culture where mistakes are well-managed and addressed, this has a positive impact on the quality of teaching and learning.

Collaboration among peers was also a notable feature of the Research Lessons observed and evaluated by the teachers. Teachers in the small school reported that this collaboration went beyond simple dialogue or communicative exchanges, the children were also observed to show appropriate regard for each other; to support each other; and to take turns, particularly when sharing explanations of their thinking and solutions to problems and tasks. The findings suggest an intuitive link between teachers increasing promotion of maths talk and observable increases in children collaborating [See sub-section 5.1.2 – Pedagogical content knowledge]. The teachers and researcher observed positive levels of engagement among children in the Research Lessons, particularly when they were working on tasks or problems in small groups. One teacher self-reported an increase in empathy with the children in the school as a result of engaging in Lesson Study, although this was a less cogent finding.

Inclusive and differentiated learning

As previously noted in the discussion [See sub-section 5.1.2 – Curriculum in practice], the teachers reported that Research Lessons also promoted an inclusive learning environment for the children. Questions, problems and tasks were appropriately differentiated, offering the children a more individualised learning experience. Moreover, the teachers reported to use assessment and observation data effectively to fine-tune their lessons and set realistic and targeted goals for the children's learning [See 4.2.4 – Identification of 'teachable moments']. In doing so, it is suggested that the learning environments provided to the

children in the Research Lessons were a good representation of the curriculum aspirations for inclusion espoused in the research reports underpinning the new primary mathematics curriculum (Dooley et al., 2014; Dunphy et al., 2014) and the background paper and brief for the development of the curriculum (NCCA, 2016b).

Across all cases, as similarly found by Hurd and Licciardo-Musso (2005), the teachers also reported that the children responded well to the differentiated tasks provided in the Research Lessons. Consequently, this led to teachers raising their expectations of children's learning and even some teachers becoming reportedly more inclined to stretch or challenge the children in other areas of learning as an unanticipated outcome of Lesson Study. Moreover, given the observed benefits and progress made by the children in response to differentiated problems, questions and tasks in the Research Lessons; the teachers subsequently reported to become more and more intentional and fastidious in their formulations of tasks and learning activities. Arguably, the children's response to differentiated instruction may also correlate with their increased openness and receptiveness to different teaching styles, another unanticipated outcome by the teachers. Moreover, there are plausible links between teachers' facilitation of an inclusive learning environment and improvements to teachers' practice as a result of their engagement in Lesson Study, such as their increased capacity to meet the demands of the new curriculum [See sub-section 5.1.1] and improvements to their enhanced knowledge and instructions practice [See sub-section 5.1.2]. In particular, the identification of 'teachable moments' was strongly attributed by the participating teachers to promoting inclusive and differentiated learning experiences [See sub-section 5.1.2 – Subject-matter knowledge]. Notwithstanding, further research would be needed to make definitive claims about these links.

5.2 How did it work, for whom, and in what conditions?

Given that teachers occupy an essential role in enacting new curriculum and bringing policy aspirations into reality (Callan 2006; Sahlberg 2011), the question as to whether Lesson Study would work in the Irish context, particularly from the perspective of Irish primary teachers themselves, was an important area of research for this study to address. A primary consideration when recruiting schools to participate in this study was the school size (number of teachers and children in a given school). This particular variable (school size) was essential to evaluating Lesson Study in the Irish context, as the demographic of primary schools in Ireland is relatively unique in comparison to jurisdictions where Lesson Study has

a more established tradition, such as Singapore [See section 4.2 for more information on the research sample].Given the uniqueness of the Irish primary school structure, the challenge of PD provision to support the enactment of primary curriculum in Ireland is also relatively unique. Evaluations of Lesson Study in international contexts such as China (Fan Yang, 2013), the US (Takahashi et al., 2013), and Singapore (Tan-Chia et al., 2013) are useful, as is empirical research at post-primary level in Ireland (Ní Shúilleabháin and Seery, 2017). However, empirical research specific to the Irish context was warranted to determine if Lesson Study would work in Irish primary schools and for Irish primary teachers.

The test model of Lesson Study implemented in the study is outlined in programme theory logic model [See sub-section 3.4.1 - Figure 4]. Moreover, the profile of participants and Lesson Study teams is outlined in sub-section 3.2.2 [See table 3]. To determine if Lesson Study had worked in the context of each of the three schools, and in what conditions, each Lesson Study team critically evaluated and refined the ToA or test model of Lesson Study implemented in the study [See sub-section 4.1.2]. The findings in terms of participants' critique of the test model, and teachers' reflections on their Lesson Study experience are herein discussed. Moreover, the refined ToA, and in particular, teachers' perspectives as to the optimal conditions for Lesson Study is discussed. In addition to the structural and logistical conditions necessary for Lesson Study to work effectively, socio-environmental factors such as the social exchanges and cultural features of the school that occur within the physical environment, but which also influence the effectiveness of how Lesson Study operates (Lave, 1991), are considered in the discussion. It is hoped that by revealing the conditions for Lesson Study to work, as reported by the participating teachers, the external validity and transferability of findings to other settings are strengthened.

5.2.1 Critique of test model of Lesson Study employed

The initial Theory of Action (ToA) designed in collaboration with participants essentially described the test model of Lesson Study implemented in the three schools [See sub-section 3.4.1 – Figure 4]. This initial ToA outlined the context for the intervention, the supports that participants detailed as necessary for the intervention to work, and the partnerships and collaborations that were involved in the intervention. It also outlined the key conditions and resources, considered by teachers from the outset, as necessary for Lesson Study to be of appropriate quality. A critical evaluation of this model by teachers

highlighted a number of strengths of this model, and opportunities, which these teachers propose for the implementation of Lesson Study in other Irish primary schools. Conversely, it also highlighted a number of concerns held by the participating teachers, as well as perceived threats to successful implementation [See sub-section 4.5.1].

According to the participating teachers, the main strengths of the Lesson Study model tested in the study was that it was rooted in practice, focused on children's learning, and afforded teachers the opportunity to work autonomously and collaboratively. These characteristics of autonomy and collaboration align with the core values of teacher learning espoused in the Cosán framework (Teaching Council, 2016). Moreover, according to Kennedy (2014) these characteristics hold promise for teachers and schools to make real progress with educational reforms, and are, according to Harold Hislop, chief inspector with the Department of Education, "at the heart of effective schools" (DES, 2013, para 24). The Lesson Study environment was also reported to enable the teachers to engage in informative professional discussions and reflective practice which are considered key tools for improving instructional practice through Lesson Study (Gutierez, 2015b). Many participants also reported that a significant opportunity which the Lesson Study model offers to Irish primary schools is the positive culture and staff cohesion it promotes as a result of teachers learning together, affirming and encouraging each other and building mutual trust, all key features of schools that are effective learning communities (INTO, 2010). Furthermore, across the research schools, Lesson Study was found to promote collegiality, mutual respect, shared goal-setting, and continual professional learning, which Day (2002) contends are characteristic of schools that best manage curriculum reform and imposed change.

Conversely, time management and workload issues were highlighted by participants as the main weakness of the test model of Lesson Study implemented in the study. In particular, teachers held concerns about the time dedicated to planning and teaching the Research Lesson topic (Place Value) to the potential neglect of other areas of the curriculum, with a strong view shared by participants that teachers are already time poor. This led to reported scepticism as to how sustainable Lesson Study might be in Irish schools as a broader model of CPD. A study by Chiew (2009) attributed such scepticism to teachers' lack of awareness and appreciation for the importance of PD. Notwithstanding, the characterisation of Lesson Study as time-consuming and putting additional workload demands on teachers is also noted in other studies (Goh et al., 2007; Chiew, 2009). Furthermore, teachers reported that facilitating the logistics of teachers observing Research Lessons and covering each other's

classes to facilitate Research Lessons during the school day caused some disruption to teachers and the children. One special education teacher noted the potential disturbance this might cause to children with special educational needs or for children who have an aversion to changes in their typical daily schedule.

As part of their evaluation, teachers cited a number of threats or barriers that they foresaw to the successful implementation of this Lesson Study model in schools. This included lack of leadership support within schools, lack of interest or motivation among staff, negative staff culture, the saturation of schools with policy demands, and poor management of teacher readiness for curriculum change. In addition, participating teachers cited inaccurate perceptions and expectations of Lesson Study as potential barriers to its success as a model of PD, a particular aspect of Lesson Study which Gero (2015) also queried in terms of its prospect as a model of PD in the US. Whilst not cited explicitly as threats to Lesson Study, teachers' individual testimonials of Lesson Study also echo a number of challenges identified in Gero's (2015) study, such as apprehensions about collaborating, marrying opposing ideas for teaching the Research Lessons, critiquing lessons and teaching in front of other teachers. Whilst the collaborative nature of Lesson Study was welcomed in principle (Chokshi and Fernandez, 2004), the participating teachers cautioned that if this approach to working together professionally is not in the school culture, with established protocols in place, then Lesson Study has the potential to cause discomfort, particularly around observations of live Research Lessons. Correspondingly, it would hold also that, as recommended by Brown and Poortman (2018), the composition of Lesson Study teams requires careful consideration and attention.

Teachers also stressed that for Lesson Study to work effectively in Ireland, there would need to be a concerted effort at system level to complement, support and uphold the principles of teacher agency, professional judgment and local decision-making inherent in Lesson Study. Given that a number of recent education policy developments in Ireland have similar underpinning principles [See sub-sections 2.2.5 and 2.2.6], it holds that Lesson Study has the potential to complement and reinforce these policy aspirations. Notwithstanding, the participating teachers cited standardised testing, textbooks and inspectorate evaluations as the main threats to these principles being achieved in actuality.

5.2.2 Support from school leadership

According to Shingphachanh (2018), school leaders play a vital role in enabling teachers to engage with Lesson Study confidently and meaningfully. Across all cases, teachers cited the importance of support from school leadership to enable the Lesson Study process to occur and make more manageable. Notwithstanding, teachers reported varying experiences in terms of support from school leadership. Teachers in the large school reported having difficulty managing the logistics of organising cover for their classrooms to allow for observation of Research Lessons. Teachers in the medium school reported improved acknowledgement and support from staff in their school where the staff were informed of and/or involved in Lesson Study. The principal of the small school was a member of the Lesson Study team and teachers reported that there was a culture of observation, team-teaching and open classrooms already established in the school before commencing Lesson Study. Accordingly, in comparing the ratings and feedback from teachers across all of the school, the teachers in the small school were most positive about their experience with Lesson Study and its success as a model of PD to support them to enact the curriculum. These findings suggest that the success of Lesson Study is strongly contingent on leadership and support available in the school. Relatedly, Tan-Chia et al. (2013) queried the extent to which schools can experience success with Lesson Study in the absence of support from school leadership.

5.2.3 Optimal conditions for Lesson Study to support curriculum enactment

Structure and logistics

Analysis of the refined Theory of Action (ToA) [See sub-section 4.5.3] proposed by teachers offers insights into the optimal conditions for supporting curriculum enactment in Irish primary schools at a broader level. As recommended by Sugrue (2011), the school as the site for teacher professional learning and development was strongly welcomed by the participants, with teacher's own classrooms considered the optimal setting for improving teaching practice (Gutierez, 2015a). As similarly found by Garet et al. (2001), participating teachers expressed the desire to work collaboratively with teachers teaching at similar class levels, on curriculum areas of particular interest to their individual contexts, with a focus on specific class levels of groupings. In small schools, where it is less likely that teachers will have the opportunities to work with colleagues teaching at a class equivalent level,

teachers expressed a preference for working in clusters with other small schools, who experience similar challenges in enacting new curriculum in multi-grade classrooms. Notwithstanding teacher's penchant for classroom based learning, participating teachers also described enjoying the opportunity to meet a broad range of teachers at regionally organised PD events and suggested that induction PD sessions on the broad aims and structure of the new curriculum might be best offered in central regional locations, with more practice-specific PD offered in individual schools.

In terms of how Lesson Study might best be facilitated in schools, rather than full days, as experienced be teachers in the study, the teachers expressed a preference for Lesson Study to be facilitated in schools over half days. In this case, research classes could remain on-site for Research Lessons and as such, reduce the level of potential disruption to schools. In terms of external support for schools, teachers expressed a preference for a combination of on-site facilitated support and access to remote support with Knowledgeable Others. Moreover, teachers recommended that Lesson Study not take place in schools during entry and exit months in the academic year, in Ireland these months are September and June. In the spirit of minimising disruption to schools, the teachers also suggested the use of Croke Park hours to conduct certain stages of the Lesson Study cycle, such as studying curriculum or planning Research Lessons. Furthermore, whilst not explicitly suggested by participants, Takahashi and McDougal (2016) suggested that at a meta-level, structural supports such as school improvement plans, steering committees and school-wide scheduling of Lesson Study might also optimise the effectiveness of Lesson Study in schools.

The extent to which these suggested refined conditions might make a difference to curriculum enactment would merit further investigation. According to Pawson and Tilley (1997, 198) this approach to reviewing the evidence of evaluations is at the heart of theory-driven and realist evaluations, where the goal is to learn "more and more about less and less". In any case, the suggested conditions for optimising the success of Lesson Study would likely require substantial resourcing, however this might be considered an investment worth making (Brown and Poortman, 2018).

Sustained support provision

According to Sahlberg (2009) specific approaches to the in-service training of teachers is needed to bridge the gap between intended and enacted curriculum. As forecast by Darling-Hammond and McLaughlin (2011), the participating teachers strongly expressed the

need for sustained support to be provided to schools, so as to enable them to continuously improve their knowledge for teaching the new primary mathematics curriculum. Correspondingly, the literature stresses that repeated cycles of professional learning and development are necessary to develop the complex array of knowledge, skills and dispositions necessary to improve classroom practice (Fennema et al., 1996; Clarke and Hollingsworth, 2002; Jaberg et al., 2002). This offers a strong caution that Lesson Study is unlikely to be effective if it is used as a one-off PD event, a point also raised by Seleznyov (2019). Rather, it is apparent from the literature that teachers need to engage in repeated cycles of Lesson Study, which raises concerns about its sustainability (Tan-Chia et al., 2013). Notwithstanding, the use of Lesson Study at initial teacher education level in Ireland is becoming increasingly prevalent and it could be argued that adopting Lesson Study at in-service level may serve to harness the positive results and benefits to teachers learning and development found at pre-service level (Corcoran, 2011b; Leavy and Hourigan, 2016).

Access to Knowledgeable Other

Whilst Lesson Study might be considered easy to do, doing it effectively is more challenging (Lewis et al., 2006). Knowledgeable Others play an important role in ensuring that Lesson Study is effective (Takahashi, 2014b). Huang et al.'s (2017) study highlighted that repeated teaching and immediate feedback from Knowledgeable Others was a key determinant for improving teachers instructional practice, which raises further questions as to the potential for the Knowledgeable Other to enhance the success of Lesson Study, which would be useful to explore further in the future. The qualities and traits of the Knowledgeable Other were also highly regarded by the participating teachers. The ability for this support professional to be flexible, adaptable, affable, non-authoritative, empathetic and resilient were stressed. The level and breadth of teaching experience that the Knowledgeable Other holds was also noted as important to the success of Lesson Study. Given the extent to which participants stressed the need for support from the Knowledgeable Other, and the prevailing tradition in Ireland for PD to be external facilitated and supported, this raises questions about Irish primary school teachers' readiness to adopt the principles of autonomy and agency afforded in Lesson Study.

Protocols around the Research Lesson

The Research Lesson provides a critical space for planning for children's lived experiences of learning (Lee and Lo, 2013) and consequently for teachers to naturally connect new instructional ideas with their own practice (Takahashi et al., 2013). Participating teachers carefully and collaboratively studied existing materials and research; and engaged in the planning, teaching and observation of Research Lessons which produced a plethora of positive outcomes [See section 5.1] and resulted in a renewed understanding of maths pedagogy (Ermeling, 2010). Notwithstanding the successful outcomes, the conditions for preparing, teaching and reflecting on Research Lessons was nonetheless critically reviewed by the participants, with the importance of peer relationships and protocols highlighted as a result. Interestingly, a recent study by Barber (2018) similarly concluded that positive outcomes from engaging in Lesson Study were contingent on clear protocols around the process and positive internal relationships among the professionals involved.

Teachers recommended that professional conversations around the Research Lesson should focus primarily on children's learning, so as to avoid judgement of peers personal teaching styles and approaches. This suggestion was unsurprising given teachers' tendency to equate observations of their practices with some kind of evaluation or judgement of performance, rather than within the context of professional learning and development (Dudley, 2011). In a similar way, the participants suggested that Research Lessons need to be carefully and sensitively managed, particularly given how challenging it can be to be fully honest and negotiate conflicting ideas and opinions during the process [See sub-section 4.2.1 - Lesson Study considered a worthwhile and enjoyable PD experience]. Teachers also highlighted the importance (and challenge) of being open to taking risks and to changing and adapting. By embracing this kind of uncertainty, Lieberman (2009) suggests that the Lesson Study process can better inform future practice.

Nature of engagement

Weaknesses identified in the implementation strategy for primary curriculum reforms introduced to schools in 1999 included insufficient opportunities for teachers to critically reflect and deepen their understanding of the methodologies and principals of the curriculum, and generic in-service provision that was not sufficiently tailored to schools individual needs (Murchan et al., 2005). Given the emphasis on pedagogical change in the

new primary mathematics curriculum [See NCCA, 2016b], this suggests the need for an alternative approach.

The National Research Council (1996, 2000) proposes that teacher PD activities should allow for direct engagement with the actual description of reform represented in reform materials. Given the socio-constructivist theoretical grounding of the new primary mathematics curriculum and the emphasis on children developing and refining their learning collaboratively [See sub-section 2.4.7], it could be argued that the ways that teachers engaged in professional learning and development though Lesson Study is congruent with and complements how children ought to learn with the new curriculum. Moreover, given the increasing prominence afforded to the social dimension of teachers professional learning and development (Grossman et al., 2001; Hord, 2004; Fullan and Hargreaves, 2016), it holds that the collaborative nature of Lesson Study (Takahashi and McDougal, 2016) adds to its merit as a PD model for enactment the new primary mathematics curriculum.

5.3 Why did it work?

By identifying and analysing the causal and contextual factors which account for the anticipated and unanticipated outcomes from the teachers' engagement with Lesson Study, this study aimed to reveal the underlying mechanisms of Lesson Study as a model of PD to support Irish primary teachers to enact the new primary mathematics curriculum. The categorisation and ranking of determinants, as well as teachers' qualitative feedback, provide keen insights to explain why Lesson Study had or had not been effective in supporting teachers to enact the new curriculum. Smith and Southerland (2006) propose that to ensure curriculum is enacted as intended; then implementation models and methods ought to consider internal and external dimensions of change for teachers. As such, the findings which describe causal attribution of Lesson Study to the outcomes determined in the study will be discussed in terms of both dimensions.

Before discussing the analysis of causal attribution findings, it should be noted that the categorisation and ranking of determinants by participating teachers highlighted a number of discrepancies. The most critical determinants for supporting teachers to enact the new primary mathematics curriculum was the time and space which Lesson Study provided to think about curriculum enactment in the classroom, opportunities it provided teachers to share, reflect, discuss and collaborate with colleagues, opportunities it provided to observe

and discuss the Research Lessons and the children's responses to instruction and observable progress made to their learning over the evaluation period. However, these determinants were attributed to outcomes at different levels [See sub-section 4.3.2]. Whilst opportunities to share and collaborate were rated favourably by teachers in terms of their satisfaction with Lesson Study and resulted in increasing collegiality, opportunities to share and collaborate were less attributable to outcomes in teachers practice and children's learning. Similarly, the determinants for outcomes in teachers' practice did not equate to the determinants for outcomes in children's learning. Notwithstanding these discrepancies, determinants will be discussed here in terms of their overall causal attribution to the successful enactment of the new primary mathematics curriculum.

5.3.1 Dedicated time, space and focus

As a research theme for Lesson Study, participating teachers placed an emphasis on supporting children's understanding of Place Value and the development of children's adaptive reasoning. Accordingly, teachers afforded much attention and focus to improving the quality of their questioning so as to elicit critical thinking and reasoning from the children in Research Lessons. In addition to self-reported improvements in their knowledge for teaching mathematics, objective measures of teacher questioning show that Lesson Study had a demonstrable impact on teacher's pedagogical content knowledge to support children's adaptive reasoning and critical thinking skills [See sub-section 4.4.1]. This also translated to improvements in children's reasoning skills both in terms of the quality and type of responses offered by children to open-ended questions [See sub-section 4.4.3].

Equally, teachers dedicated time and effort to study Place Value at a deeper conceptual level resulting in self-reported improvements in teachers' understanding of this curriculum topic, as well as their ability to identify and address misconceptions and misunderstandings of Place Value held by the children. Post- Lesson Study measures of children's understanding of Place Value show that children made statistically significant improvements in their understanding of Place Value compared with pre-Lesson Study measures [See sub-section 4.4.2]. These outcomes in teachers' learning (Level 2) and practice (Level 4) were strongly attributed to the time and space that Lesson Study provided to allow teachers to think about teaching and assessment ideas. Moreover, teachers reported that observation and analysis of children's learning, in particular their

responses to teaching activities and instruction was the most critical determinant for outcomes at these two levels (2 and 4).

Lee and Ling (2013) forefront the process of engaging in Lesson Study as central to supporting the enactment of intended curriculum. Whilst the importance of the lesson planning space has been highlighted in the literature (Fujii, 2019), in this study it was rather the post-Research Lesson discussion space that was reported and observed to provide the most potent space for teachers to interrogate and negotiate the new curriculum in the context of teaching and learning in their individual settings [See sub-section 4.2.3 – Improved collegiality with fellow teachers]. Research on the implementation of mathematics reforms by Spillane (1999) describe such spaces as 'zones of enactment' where teachers are supported to de-contextualise external reforms and recontextualise reform ideas for their own specific practice or contexts. In real terms, it was in this space that the intended and enacted primary mathematics curriculum intersected; and where novel ideas around the new curriculum were internalised, collectively discussed and reconceptualised within the context of the individual schools (Spillane, 1999; Clivaz and Ní Shúilleabháin, 2019).

As similarly found by Remillard (2005), participating teachers reported that the activities which they engaged with during each Lesson Study cycle promoted collaboration and collective reflections on their practice in the context of the proposed curriculum changes. Moreover, this collaborative space provided a forum for the participating teachers to explore how their ideas cohered or differed and they identified areas for future discussion and development [See sub-section 4.2.3 – Increased sharing and collaboration]. According to Darling-Hammond and McLaughlin (1995), it is through these opportunities for reflection and action that teachers are mobilised to accept and adopt change. Furthermore, in doing so, the principles of collaborative professionalism which Fullan and Hargreaves (2016) advocate as having the greatest potential in leading and supporting educational change, were evident in practice.

5.3.2 Witnessing curriculum enactment and children's learning progress

In addition to demonstrable improvements in teaching challenging aspects of the new primary mathematics curriculum, participating teachers also reported increased confidence to use the new curriculum, as well as feeling more equipped to adopt the changes presented in the new primary mathematics curriculum as a result of engaging in Lesson

Study. Lewis (2005) holds that strengthening of teachers' motivation and sense of efficacy can make a strong contribution to such instructional improvements. Correspondingly, teachers also described being more motivated and positive about impending curriculum changes, attributed largely to observing the direct effects of their (professional) learning on the children's learning outcomes. As foreseen by Remillard (2000) and Hanley and Torrance (2011), observing children's learning and directly witnessing children's progress was reported by teachers as a key determinant for improvements to their instructional practice.

Another mediating factor which emerged as strongly contributing to teacher's positive experience with Lesson Study was how Lesson Study facilitated teachers to take ownership of their own professional learning and engagement with the new curriculum. Beyond the identification of the research theme, the impetus for professional learning and changes to practice largely arose in response to teachable moments or moments of contingency in children's learning (Black and Wiliam, 2009) [See sub-section 4.5.1]. In this way, Lesson Study was found to foster a formative assessment culture in the classrooms where insights into children's learning directly influence the direction and nature of instruction (Lysaght et al., 2019). Sarason (1990) and Fullan (1993) hold that in the absence of ownership of change, changes to teachers practice remains minimal with teaching portraying an image of compliance or reform simply to appease policy makers and external appraisers. Given that schools who take ownership of curriculum enactment tend to be more successful in implementing curriculum reforms in practice (DES, 2005), this is a promising finding in itself.

In interpreting these findings, Guskey (1987) offers caution by suggesting that teachers tend to express more personal responsibility and efficacy when children are successful in their learning. Given the considerable improvements in children's learning outcomes found in the study, this is a consideration worth holding. Notwithstanding, these findings suggest that seeing the curriculum being enacted and the progress made by the children provided important pathways to instructional improvement and confidence in adopting the new curriculum in practice. Moreover, these findings strongly reflect the assertion by Lewis and Hurd (2011) that Lesson Study builds a professional learning community in which teachers improve their knowledge of teaching, and their concomitant belief that changes in their own teaching can help children learn.

5.3.3 Increased collaboration and collegiality

It is widely accepted in the literature, that teachers working collaboratively has a strong impact on their professional learning and development (Campbell et al., 2016). Recent studies by Samaranayake et al. (2018) and Gunnarsdóttir and Pálsdóttir (2019) show a strong link between collaboration and teacher change and the potential for Lesson Study to hone both of these through engagement with the Lesson Study process. Whilst a couple of teachers expressed apprehensions about observing lessons and managing opposing ideas for teaching the Research Lesson; in the main, teachers reported that engaging with Lesson Study had increased their sharing and collaboration, and improved their collegiality with fellow teachers [See sub-section 4.2.3], a finding also determined from Cajkler et al. (2014) in a study with UK teachers. As similarly found by Ermeling (2010), by sharing the problems of discovering connections between children's learning and understanding; and the Research Lesson, teachers' practice was refined through the Lesson Study process. Participating teachers reported that the planning sessions and post-Research Lesson discussions provided a meaningful opportunity to share and discuss ideas (Canonigo, 2016) and that the focus on the children's learning in the Research Lesson provided a non-threatening medium for these discussions. According to Lee and Ling (2013, 200) "it is *only* through this collaborative discourse among teachers, supported by Knowledgeable Others, that reform ideas can take root in classrooms and bring about lasting change".

Across all schools, teachers reported increased collaboration and sharing among teachers. A key determinant for these outcomes reported in the study was the deepening of collegial relationships among the participating teachers in their respective Lesson Study teams, with teachers noting greater regard and empathy for their colleagues. Again, the professional conversations held by teachers around the Research Lesson were attributed strongly to helping to build trust among teachers and to allow them to learn from each other [See sub-section 4.2.3]. This was not an automatic output of Lesson Study but rather an outcome which emerged over time (Takahashi and McDougal, 2016). With each Lesson Study cycle, teachers had more opportunities to work and plan together, to establish openness and trust and get a better understanding of each other's working style. For the large school, it was not until the third cycle of Lesson Study that trust and ease around the process was established. Notwithstanding, despite self-reported improvements in collaboration, sharing collegiality in their schools; teachers in the large school reported to be less enthusiastic about possible future collaborative work in their school than teachers in the small and medium school.

Finally, Lewis and Perry (2010) hold that compared with teachers who do not participate, teacher participants in Lesson Study are more likely to report that learning with colleagues is effective and enjoyable, and they are thus more inclined to collaborate regularly with their colleagues as a result. In the context of this study, most teachers reported that the opportunities they had to work collaboratively with their peers was informative, productive and enjoyable.

5.3.5 Time demands and managing change

Analysis of teacher's individual testimonials and group interviews showed that time demands, and perceived responsibilities of teachers were critical determining factors in teachers embracing Lesson Study, a determination also made by Ní Shúilleabháin and Seery (2017) and Karabuğa and Ilin (2019). Lesson Study attracted criticism from some teachers in the large school, who reported that too much time was afforded to too little of the new curriculum [See sub-section 4.6.1]. This raised concerns amongst a couple of the participants as to how equipped teachers would be to enact the full curriculum, if this model of PD (three cycles of Lesson Study) was provided to teachers more generally. Teachers in the small and medium school were more positive about Lesson Study as a use of their PD time. In response to these criticisms, Seleznyov (2019) offers a caution that Lesson Study is not considered an end in itself, rather as a means to realise change in selected aspects of teaching and learning. In the context of this study, teachers were asked to identify an aspect of the curriculum that was challenging to teach and difficult to learn. By identifying specific aspects to focus on for Lesson Study activities (Place Value and adaptive reasoning in this case), it is suggested that Lesson Study was used optimally to support enactment of the proposed curriculum changes selected. Furthermore, at least one teacher from each Lesson Study team reported that Lesson Study helped them to think differently about the curriculum overall and change their mindset about mathematics education.

On reflection of the list of determinants [See sub-section 3.5.4 – Table 15] participating teachers rated the teacher toolkit, a suite of 11 curriculum support materials provided to teachers [See sub-section 3.4.1 - Figure 4] as considerably less attributable to successfully supporting curriculum enactment than other determinants. Equally, the participants afforded little credit to working with the Knowledgeable Other as a determinant of Lesson Study's success, with teachers observed to work predominantly on their own initiative to research the Lesson Study themes and progress their professional learning. Aho et al.

(2006) suggest that identifying such potential and hidden capacities of schools and teachers; and facilitating the exchange of good ideas and practices among them is a critical missing link in bridging the curriculum implementation gap.

Overall ratings of success indicators across each of the five levels of PD evaluation show that Lesson Study teams in the small and medium school reported Lesson Study to have met their expectations and anticipations to a greater extent. Notwithstanding, teachers across all school expressed concerns about the sustainability of Lesson Study given the time demands and resourcing necessary for it to work most optimally. Given the extent to which it relies on support from the school community, this resourcing was described as essential by the participants.

5.3.6 Other considerations for understanding change

Given the non-experimental nature of the evaluation, teachers were also asked to reflect and suggest other explanations for causal attribution and consider possible inhibitors to Lesson Study's effectiveness. Additionally, in the absence of a control group, participants were asked to estimate the counterfactual by postulating how they think their experience may have differed if they had engaged with a more traditional model of PD to support them to enact the new primary mathematics curriculum.

Alternative explanations for Lesson Study's effectiveness

Teachers cited that the novelty of Lesson Study and the new curriculum may have contributed to their enjoyment in engaging in Lesson Study. By the teachers own admission, and by virtue of the fact that teachers in the study volunteered to participate in the study, it is reasonable to assert that the participating teachers were largely agreeable and open to exploring the new curriculum and engaging in Lesson Study from the outset. As such, it cannot be assumed that the sample group is representative of all teachers in Ireland, nor that similar outcomes would be reported from a wider teacher sample (Tsang, 2014).

Given the plethora of intervening contextual variables at play, it is impossible to determine to what extent teachers' new learning and practice could solely be attributed to Lesson Study despite the breath of self-reported evidence provided by the participating teachers [See sub-section 4.3.1]. It is plausible that teacher's prior knowledge and experience of

teaching Place Value may have contributed to the quality of the teaching evident in the Research Lessons. Moreover, two of the teachers also participated in short CPD courses in maths over the period. The teachers also suggested that participation in team-teaching activities in other subject areas (for example, literacy) may also have contributed to deepening the teacher's collegial relationships and ability to work collaboratively.

Furthermore, the teachers described the autonomy afforded to them through Lesson Study as empowering and an acknowledgement of their expertise as educators. Teacher autonomy is a central tenet of Cosán, the National Framework for Teachers Learning in Ireland (Teaching Council, 2016) which represents a shift in traditional ideals of teacher professionalism, roles and identity [See sub-section 2.2.6]. Given the centrality of teacher roles and identity to sustaining motivation, efficacy, commitment, and job satisfaction during periods of externally imposed education reform (Day, 2002), this is a key consideration for future research endeavours.

Possible inhibitors to Lesson Study's effectiveness

Differences in support from school leadership and awareness of the wider school staff about Lesson Study across each of the three schools was found to have an impact on the outcomes reported by Lesson Study teams [See sub-section 4.2.3 – Causal attribution at Level 3]. Given that these outcomes were indicative of Lesson Study's success, the findings suggest that school leadership and involvement of the wider school community play an important role in the effectiveness of Lesson Study to support teachers to enact new curriculum, particularly in terms of managing time, logistical demands and workload on teachers and schools (Arani et al., 2010).

In the months prior to the research study taking place, teachers in Ireland, including the participating teachers, had engaged in initial PD for a new Primary Language Curriculum. In line with recent findings by Jhang (2020) on the impact of attitudes to Lesson Study on teacher's participation, a few teachers reported that scepticism and mixed responses to this new curriculum held by the wider teaching community may have influenced their attitudes to engaging in the intervention and as such, resulted in reluctance to engage with Lesson Study, at least initially [See sub-section 4.2.2. Causal attribution at Level 2].

Furthermore, teachers suggested that Lesson Study may have produced more positive outcomes if it had taken place at a different time in the academic calendar, with the final term deemed as less ideal given the busyness of schools in managing different aspects of

school life such as the administration of standardised assessments, school trips and reporting to parents. The lack of substitute teachers available at this time of the year was also noted as a challenge for teachers.

Estimated counterfactual outcomes with traditional PD models

By facilitating teachers to analyse and estimate counterfactual outcomes with traditional PD models, further insights were gained into their views on Lesson Study's effectiveness as a model of PD to support curriculum enactment. Participating teachers reported that from their experience, traditional PD typically focuses on navigating curriculum documents, resources and equipment and external expectations around planning. By comparison, the teachers described how traditional PD does not offer that which teachers found of most valuable with Lesson Study; namely trying out the curriculum in real time, listening to children's responses and reactions to what has been taught. An evaluation of the implementation of the current curriculum in schools (DES, 2005) highlighted an overemphasis on traditional, didactic and teacher directed learning. In contrast, Lesson Study was found to orientate teachers' professional learning and development around the child's learning. This direct involvement of children and the centrality of the child's learning to the Lesson Study process strongly contrasted it with traditional PD models, with teachers reporting Lesson Study to be more practical to support enactment and more satisfying in terms of directly seeing the outcomes of their efforts for children's learning. Given that traditional teacher PD models have been criticised for inadequately equipping teachers for the complexity of improving children's learning in classrooms (Little, 1993), these comparisons suggest that Lesson Study may hold better potential to bridge the gap between intended and enacted curriculum.

In comparing their experiences with traditional PD, teachers reported Lesson Study to be more empowering, more helpful and more uplifting for teachers. The 'fishing' analogy shared by one particular teacher (Molly) stands out in encapsulating teachers views on the differences between Lesson Study and traditional PD

> *"The typical CPD we are used to is like giving us [teachers] fish while Lesson Study teaches us how to fish so we can do it for ourselves".*

This view of teacher PD corresponds with more contemporary views of teacher professionalism (Kennedy, 2014), and aligns with recent national policy developments

(School Self-Evaluation - DES, 2012; 2016; Cosán - Teaching Council, 2016; and Droichead - Teaching Council, 2017).

5.4 Embedding evaluation in professional development

Evaluations of PD interventions typically focus on teacher reactions and levels of satisfaction with the PD event (King, 2014). Curriculum enactment (or implementation) is typically evaluated by external inspectors or researchers and adopts an etic perspective to evaluation primarily (Faubert, 2009). In contrast, TDE adopts an emic perspective by evaluating from the insider's perspective of curriculum enactment and as such, is arguably thus more aligned with contemporary Irish education policies on evaluation which promote teacher agency and autonomy as aforementioned.

In reviewing and reflecting on their experience with TDE [See section 4.7], participating teachers praised the TDE process as non-threatening, personal, flexible, practical and targeted in evaluating Lesson Study in a meaningful way, or rather in a way that they themselves deemed to be important in supporting them to enact the new primary mathematics curriculum. According to School Self Evaluation Guidelines in Ireland (DES, 2016), leading and changing schools is best conducted within schools, by people who know their school setting best. In the context of this study, theory-driven evaluation allowed for teacher involvement and engagement of Irish primary teachers, the primary stakeholders of the evaluation, at all stages of the evaluation. In addition to being helpful to determine the merit of Lesson Study as a model of PD support them to enact the new primary mathematics curriculum, the direct involvement of teachers also served to establish a better understanding of the causal mechanisms at play in the unique context of Irish primary schools. Despite adopting a different model of evaluation, Godfrey et al. (2019), in their evaluation of the impact of Lesson Study in London Schools, similarly sought to engage teachers throughout the evaluation process and similarly found that when evaluation was incorporated from the outset of the Lesson Study process, it held the potential to "build focus and coherence to teachers' learning, maximising the kind of high-quality professional discussion and skills development that leads to positive outcomes for pupils" (Ibid, 325).

Guskey (2017) holds that educators often shy away from and neglect evaluating their professional learning experiences because they see it as necessitating expert knowledge and skills. As such, evaluations tend to be summative, ad hoc, and less likely to result in improving the quality or effectiveness of teachers' professional learning and development

(Ibid). Contrastingly teachers who participated in the study reported that participating in the TDE process fostered collective efficacy and ownership of successes and failures of the evaluation; and promoted confidence in their ability to manage their own professional learning and development journey. Moreover, the teachers reported that the process of evaluating themselves was constructive and they found themselves more likely to take risks in the knowledge that they were not being evaluated externally. Furthermore, teachers reported that the TDE process promoted teacher agency and autonomy which is promoted in recent education policies such as Cosán (Teaching Council, 2016) and is integral to the principles of school self-evaluation and improvement planning (School Self-evaluation Guidelines – DES, 2016).

Notwithstanding these reported strengths and opportunities, teachers also expressed concerns that TDE is time-demanding; and compared with traditional evaluation approaches, is relatively insular and lacks external insights or knowledge. Teachers also questioned the potential rigour of self-evaluation of PD to support curriculum enactment in the absence of national standards or comparisons to other schools and teachers. In line with concerns held by Kyriakides and Campbell (2004), the participating teachers also suggested that lack of teacher readiness, lack of support from school leadership, and resistance and reluctance to change were key threats to embedding self-evaluation in professional learning and development. Finally, teachers stressed that inconsistencies in how concomitant evaluations by the Irish education inspectorate might be conducted in schools, would likely have a strong impact on the extent to which such an evaluation process might be received in schools.

In addition to criticising the lack of focus on planning for curriculum implementation in Ireland, Walsh (2016, 10) also noted the "lack of provision for the systematic and continuous evaluation of implementation". On reviewing the evaluation of CPD established to support implementation of the most recent curriculum reforms in Ireland, de Paor (2016) similarly stressed the importance of incorporating a focus on evaluating the impact of PD programmes, not just at the end of the PD process, but on an on-going basis and in a way that informs planning for future CPD. Given that Irish teachers are increasingly being afforded a more autonomous role in decisions about their professional learning and development (for example, Cosán – Teaching Council, 2016), de Paor (2016) holds that this focus on impact, by and for teachers, is likely to become more relevant and important.

5.5 Lesson Study as transformative space

As authoritatively stated by Priestly (2016), curriculum policy can only ever act as a statement of intent, what unfolds in terms of curriculum enactment is a result of teachers understanding of these intentions. It is well established in the literature that to adopt and make sense of curriculum reform and enact intended curriculum changes, teachers need to engage in meaningful professional learning and development (Spillane, 1999; Spillane et al., 2002). Considering the broad contemporary PD literature base, the evaluation of Lesson Study in this research study highlighted how Lesson Study complements many of the conditions for, and characteristics of, effective PD (Cordingley et al., 2003, 2005, 2007; Timperley et al., 2007; Darling-Hammond and McLaughlin, 2011; Maskit, 2011). In particular, Lesson Study was found to support teachers to work collaboratively with their peers to successfully engage with and contextualise curriculum messages for their classroom practice. Lesson Study activities, particularly post-Research Lesson discussions were found to especially important mediums for engaging in rich discourse and deliberation on the new curriculum. Darling-Hammond and McLaughlin (1995) hold that it is through such opportunities that teachers can self-reflect, question, analyse and ultimately change their thinking and modify classroom practice.

Research findings show that Lesson Study provided a transformative space where participating teachers could interrogate and try out the new primary mathematics curriculum. This engagement in Lesson Study resulted in enhancements to teachers' knowledge for teaching mathematics, gains for children's learning and supported teachers to meet the demands of primary mathematics curriculum reform. In explaining this change, the research findings show that Lesson Study effectively addressed both internal challenges and inhibitors to curriculum change (Smith and Southerland, 2006), such as teachers readiness and confidence to enact change (Hopkins and Reynolds, 2001; Harris, 2003), as well as positively influencing external and contextual factors that pre-requisites to curriculum change, such as the classroom and school environment in which curriculum is enacted (Jones, 1997; Gess-Newsome et al., 2003).

Importantly, Lesson Study is not proposed in the literature as a quick shot solution to curriculum reform, rather Seleznyov (2019) holds that with time and repeated cycles of engagement, new ideas can be integrated into teachers existing thinking and new practices can be adopted. For Walsh (2016), this kind of integration and assimilation is essential for proposed curriculum change to become enacted in reality. The results from this evaluation

of Lesson Study serve to affirm that Lesson Study has strong merit and potential as a model of PD to support enactment of the new primary mathematics curriculum, as well as curriculum reform in general.

Chapter 6. Conclusion

6.1 Overview of context and rationale for research

Primary curriculum in Ireland is entering a period of extensive redevelopment, which has at its core, the aim of making teaching and learning in Irish primary schools more meaningful and relevant. However, the development of a new curriculum is but curriculum change 'in theory' (NCCA, 2007). The enactment of curriculum is far more complex and requires teachers to renegotiate their thinking, beliefs, knowledge; and ultimately their decision-making and actions in the classroom, so as to align with the aspirations of new curriculum. Teacher PD is widely held as the most critical mediating factors between education reforms and successful changes to children's learning and achievement (Guskey and Huberman, 1995; Ball and Cohen, 1999; Elmore, 2002) as it has the potential to bring broad, externally validated reform ideas into contact with local and contextualised teaching and learning situations (Elmore, 2006). To ensure that intended curriculum is realised in practice, sophisticated curriculum enactment support models and methods are required (Smith and Southerland, 2006) which are informed by knowledge or insights about the process of curriculum change (Sahlberg, 2006, 2009). Hargreaves et al. (2001) suggest that determining the effectiveness, quality, relevance and impact of different PD programmes provides a useful contribution in this endeavour.

The publication of a new primary mathematics curriculum in Ireland is imminent. To contribute to the research base and, in doing so, inform curriculum policy planning and practice in support of the enactment of this new curriculum, this presented two challenges to the study. Firstly, to select a credible and tenable PD model to investigate; and secondly, to evaluate the effectiveness of said PD model such that it provides appropriate insights into the experiences of teachers and also the insights as to what, how and why this PD supports enactment of the curriculum, or not, as the case may be.

The selection of Lesson Study as a model of PD to test and evaluate in the Irish primary context stemmed largely from its increasing prominence and established success in supporting teacher professional learning and development; and owing to its growing evidence base as a model of PD to support the enactment of curriculum reform [see sub-sections 2.4.2 and 2.4.3]. The new primary mathematics curriculum presents new perspectives for teaching and learning mathematics in Irish primary schools which necessitate new thinking and approaches to pedagogy in the classroom (NCCA, 2016b).

Lesson Study has been explicitly identified by Dooley et al. (2014) and Dooley (2019) as a rich model of PD to facilitate the kind of professional learning and development required for Irish primary teachers to adopt and enact the new Irish primary mathematics curriculum. Overall analysis of the broad literature also gave strong credence to the potential for Lesson Study to address specific challenges for enacting pedagogical changes introduced in the new curriculum [see sub-section 2.3.5] which justified further investigation in Irish primary schools. In particular, the collaborative nature of Lesson Study was spotlighted as valuable to deepen teachers insights and understanding for teaching and learning mathematics (Dooley, 2019), and to interrogate and negotiate curriculum change at local level with colleagues as it relates to their specific context (Ní Shúilleabháin and Seery, 2017).

6.1.1 How the study addressed research aims and goals

Notwithstanding the increasing prominence of Lesson Study as a PD phenomenon internationally and in Ireland, a review of the literature revealed a paucity of substantive research to affirm the merit of Lesson Study to support Irish curriculum enactment at primary level. As such, it was of interest to this study to investigate Lesson Study as a model of PD in Irish schools with Irish primary school teachers. In doing so, the study also aimed to contribute to the research base on Lesson Study in the context of primary curriculum reform, for which there is little or no extant empirical research. In addition, this research also aimed to inform curriculum policy and practice in Ireland.

Despite the emphasis and importance afforded to PD, historical analysis of previous primary curriculum reform efforts in Ireland (Walsh, 2016), and analysis of Irish education policies put in place to attend the current primary curriculum (Murchan et al., 2009; Sugrue, 2011) highlighted critical shortfalls in PD provision to support previous primary curriculum change and enactment in Ireland. Subsequent governmental policy developments have emphasised the provision of effective PD as critical to effecting curriculum change and achieving curriculum policy aspirations in real terms (DES, 2017a). This stance has equally been shared at curriculum policy level (NCCA, 2017) and echoed further in research underpinning the new primary mathematics curriculum (Dooley et al., 2014). As such, this research study also aimed to respond to lessons learned from previous primary curriculum reform efforts by producing credible and relevant research findings which could inform and contribute to policy decision-making and deliberation. Given the

importance placed on ensuring that concerted planning for curriculum enactment takes place in advance of curriculum publication (Walsh, 2016), this research study is also timely.

To contribute to the research base and also be of value to curriculum reform policy and decision makers, this research study aimed to provide sound, meaningful and reliable empirical evidence of the merit of Lesson Study to support curriculum enactment (Guskey and Sparks, 1996; Hargreaves, 1996) in the specific context for which it would be implemented (Guskey and Yoon, 2009). To do so, it was of particular interest to the research to determine not just if Lesson Study would work (be effective to support teachers to enact the new primary curriculum), but also, it sought to determine in what ways, how and why it might do so in this novel context.

6.1.2 Significance of TDE approach employed

Considering the research agenda, it was critical that an appropriate evaluation methodology was selected which would evaluate the impact of Lesson Study but also identify the underlying generative change mechanisms of the intervention and the influence of context upon the outcomes. Theory-driven evaluation (TDE) was selected in response to Pawson and Tilley (1997) and Guskey and Yoon's (2009) assertion that in order for evaluations to be useful, rather than just answering the question, 'does it work?' they should also determine why it works, in what conditions, and for whom. A TDE approach was also selected because of its established suitability and usefulness in evaluating new and complex interventions (Barnes et al., 2003; Davies, 2004; Stame, 2004; Rogers, 2008).

The TDE approach adopted in this study opened the black box of evaluation to make explicit the participating teachers' implicit views and assumptions about Lesson Study; specifically their theory as to how, and why, and the different ways it ought to work in order for them to deem that it was been successful in supporting them to enact the new primary mathematics curriculum. In testing this (programme) theory, this research study established the salient outcomes that resulted from teacher's engagement with Lesson Study as well as revealing the casual determinants which led to these outcomes. Guskey's (2000) reliable framework provided a useful conceptual tool to determine the quality and extent of these outcomes and determinants at five critical levels (teachers' reactions, teachers' acquisition of new knowledge and skills, organisational support and change, teachers' use of new knowledge and skills, and children's learning). The evaluation also

identified the particular contextual factors and conditions which were of particular relevance and importance in supporting the teachers to enact the curriculum.

Given that teachers occupy a pivotal role in bringing new curriculum to life in classrooms (Sahlberg, 2011), it was an imperative of this study to directly involve teachers in evaluating PD pertaining to support them to enact new curriculum, in this case Lesson Study. Arguably, PD evaluations are of little value to teachers if the findings generated lack practical credibility and / or do not address specific issues faced by them at the chalk face. The development and testing of the teachers' programme theory made explicit, participating teachers' views about Lesson Study and subsequently framed the evaluation. Empirical evidence generated in the study then served to inform judgements as to Lesson Study's merit as a model of PD to support curriculum enactment. In this way, TDE struck a good balance between generating evidence that held both scientific and stakeholder credibility by situating teachers central to the evaluation process, whilst also contributing to Irish education research and discourse. By directly involving primary teachers, the study acknowledged the importance of teacher autonomy and agency in shaping these PD experiences and translating professional learning and development into practice. Concomitantly, in doing so, the research design employed also aligned strongly with contemporary Irish education policies [See sub-sections 2.2.5 and 2.2.6].

In summary, by applying a relatively unique research design (TDE) in this relatively unique research context (Lesson Study at primary level in Ireland), the study was able to open the black box of evaluation to generate evidence that addressed specific research questions, goals and aims that were of particular relevance and timely importance to Irish education [See section 1.1]. By investigating the impact of Lesson Study, exposing the process of change and examining the test model of Lesson Study employed in the study, this research study produced new salient findings upon which to make judgements about the merit of Lesson Study to support participating teachers to enact the new primary mathematics curriculum and, in so doing, made a new contribution to knowledge.

6.2 Merit of Lesson Study as a model of PD to support curriculum enactment

To evaluate and determine the merit of Lesson Study as a model of PD to support Irish teachers to enact the new primary mathematics curriculum, a number of evaluation strands were investigated [See section 4.5] using a mixed methods approach [See section 3.3],

which generated comprehensive findings. From analysis of these findings, it can be concluded that Lesson Study was effective in supporting participating teachers to enact the new primary mathematics curriculum.

Key outcomes

Evaluation of the ToC produced conclusive self-report findings to suggest that Lesson Study was, from the teachers' perspective, effective to support them to enact the curriculum. Findings showed that as a result of engaging in Lesson Study, positive outcomes were found across all five critical levels of PD evaluation (Guskey, 2000). At level 1 (teacher reactions), Lesson Study was found to be a worthwhile and enjoyable PD experience for teachers. At level 2 (teachers' acquisition of new knowledge and skills), teachers reported increased knowledge for teaching the new curriculum, in particular improved subject-matter knowledge for teaching Place Value and pedagogical content knowledge for developing children's adaptive reasoning skills. At level 3 (organisational change and support), teachers reported increased collegiality, sharing and collaboration with their fellow Lesson Study team members. At level 4 (teachers' use of new knowledge and skills), teachers provided quality and inclusive learning experiences and rich cognitively challenging tasks to children in the Research Lessons. They also developed students' adaptive reasoning skills through targeted open-ended questioning and the promotion of maths talk. At level 5 (children's learning), children in the research class demonstrated that they had achieved the Curriculum Learning Outcomes and aims that were selected as the focus for Lesson Study activities. The evaluation also revealed a number of unanticipated outcomes across each of the levels which served to further affirm the assertion that Lesson Study holds strong merit, most notably teachers' identification of 'teachable moments' and their provision for inclusive and differentiated learning. In addition, evaluation findings also showed Lesson Study to be influential in shifting teachers' thinking about curriculum change, their roles as teachers and in rethinking their expectations of children's learning.

Targeted objective measures of teachers' questioning (i.e. non-self-reported measures) showed that teachers increased the frequency and proportion of open-ended questions posed in their maths lessons. In particular, teachers were found to ask a proportionately greater amount of questions which asked for explanation, as well as self-evaluation of explanations. Equally, measures of children's performance on criterion-referenced Place Value assessments showed statistically significant improvements in children's understanding of Place Value and adaptive reasoning skills over the evaluation period.

Corresponding with changes to the types of questions posed by teachers in maths lesson, measures of children's responses to open-ended questions showed that children in the research classes were also found to provide proportionately fewer simple responses and more explanations and self-evaluation of responses.

Key mechanisms of change

By evaluating Lesson Study using a theory-driven approach and adopting Guskey's (2000) five critical levels of PD as a conceptual lens for investigating causation, judgements could be made as to the aspects of Lesson Study that were more or less favourable or conducive to supporting curriculum enactment across each of the levels. Overall, having dedicated time and space to discuss, interrogate, plan for and try out aspects of the new curriculum in the context of their own school was highly appraised by teachers. Having opportunities to observe live Research Lessons, and in doing so, see curriculum enactment in real time, was empowering and informative for teachers. In addition, witnessing the direct benefits of Lesson Study for children's learning outcomes and experiences resulted in teachers describing themselves as more hopeful and efficacious of their capabilities to adopt new curriculum. Working collaboratively with colleagues and having opportunities to share and reflect were found to be favourable to individual teachers as well as having benefits at school and organisational level; albeit these findings were strongly aligned with school leadership support reported across each of the cases. Moreover, having professional conversations around the Research Lessons, particularly during post-Research Lesson discussions was most pointedly attributed to positive changes in teacher's practice and gains for children's learning. On the contrary, the curriculum teacher toolkit provided to the participants, and working with the Knowledgeable Other, was reported to be less attributable to the outcomes in the study.

On reflection of their overall experience, participating teachers self-reported that outcomes for their teaching practice were attributable to Lesson Study to a good or very good extent. Likewise, there was unanimous agreement among teachers that outcomes for children's learning were attributable to Lesson Study to a very good extent. Examination of possible inhibitors, alternative explanations and estimated counterfactuals, as well as the fact that neither Place Value nor adaptive reasoning are explicitly taught to children as part of their current curriculum provision helped to give even more confidence to these findings.

Key conditions and contextual factors

The test model of Lesson Study employed in the study was, for the most part, commended by the participating teachers and reported to be conducive to supporting the enactment of the new primary mathematics curriculum and change. In particular, the practicality, focus on children's learning, and autonomy afforded to teachers were noted as strengths of the model. In addition, teachers lauded the opportunities that this model afforded them to work collaboratively to interpret, negotiate and enact the new curriculum for their own context, and the subsequent positive shifts in school culture and increased collegiality that resulted as a consequence. Analysis of the participating teachers' appraisal of the test model of Lesson Study employed in the study show that discrepancies in the level of support received at wider school level, in particular from school leaders; as well as the composition of Lesson Study teams and possible tensions in teachers level of comfort and readiness to teach in front other teachers, could account for the small variation in results between each of the case schools.

The refined Theory of Action outlined in the findings [see sub-section 4.5.3] and discussed in Chapter 5 [see sub-section 5.2.3] provides a core output from the study by outlining the key conditions and contextual factors that participating teachers propose ought to comprise a revised model of Lesson Study for more general use across Irish primary schools. The logic map of this refined model of Lesson Study for Irish primary schools, as illustrated in Figure 19, synopsises these conditions and contextual factors to offer a key starting point for researchers interested in testing, trialling and researching Lesson Study further in the context of Irish primary schools; as well as offering an evidence-based model for Irish policy-makers, PD providers and practitioners to consider and/or adopt in Irish primary schools.

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Summary

Fundamentally, curriculum reform is considered to be realised through the learning experiences of children when teachers enact new curriculum ideas and adopt new teaching content and methodologies (DES, 2005). Given that changing *how* mathematics is taught is considered to be far more challenging that teaching *what* mathematics is taught (Takahashi and McDougal, 2016), the findings indicating enhanced knowledge for teaching and assessing children's understanding of Place Value and developing their adaptive reasoning skills serve to affirm Lesson Study's merit to support enactment of the new primary mathematics curriculum. The unanticipated outcome of teachers identifying teachable

moments in the Research Lesson serves to further strengthen this claim, particularly given the importance placed on building cultures of formative assessment for teaching mathematics effectively in the new primary curriculum (Dooley, 2019). Relatedly, the promotion of inclusive and differentiated learning experiences in the Research Lessons aligns strongly with the vision for children's learning underpinning the new curriculum (NCCA, 2016b).

In summary, Lesson Study was found to play a critical role in supporting Irish teachers to enact the new primary mathematics curriculum. Through the process of studying, planning, teaching, observing and discussing pedagogical issues around a curriculum research theme, teachers were facilitated to negotiate new curriculum changes and become more attuned to the implications of these changes for their own practice and embed new pedagogical practices into their teaching repertoire that are congruent with curriculum policy goals and aims. Given the plausibility of the test model of Lesson Study employed in the study and the fact that all anticipated Lesson Study outcomes and determinants were evident in the research findings, these claims could assertively be made. Moreover, given the numerous strategies and steps taken to strengthen the reliability and validity of the data and findings drawn from this evaluation study [See subsection 3.6.3], this gives additional confidence to the reader in interpreting the conclusive claims made as to the merit of Lesson Study to support enactment of the new primary mathematics curriculum in this case.

6.2.1 Implications of findings for policy

The need to generate quality empirical evidence to inform policy and practice in Ireland is stressed in the literature (Duncan, 2005; Lunn, 2013). Given the criticality of PD to mediate curriculum policy and practice (Walsh, 2016; NCCA, 2017), it is essential that suitable research-based models of PD are put in place to attend new curriculum and support its enactment and realisation in practice (Guskey, 2001; Bernardo and Mendoza, 2009). Hargreaves (2001) holds that the quality of the research or evidence that informs policy is a core consideration for education policy makers and researchers. Lunn (2013) argues that policy is more likely to generate intended outcomes if it is informed by relevant facts and an understanding of the causal mechanisms that lead to those outcomes. This study served to generate substantive evidence of Lesson Study outcomes to affirm the merit of Lesson Study to support enactment of the new primary mathematics curriculum. Moreover, it identified the salient aspects of Lesson Study that were particularly influential in producing positive outcomes in this endeavour.

Notwithstanding the positive results of Lesson Study in this multi-site case study, it is important that policy decision-making and deliberation also take into account a number of cautions and considerations noted in the literature. Takahashi (2013, 214) highlights tensions between mandated and "grassroots initiated" Lesson Study. As such, how Lesson Study might be introduced to schools would need further exploration. In Japan, a systematic approach to Lesson Study has become embedded in education and school culture over time. This systems approach serves to further enhance the effectiveness of Lesson Study in this context. Given the conditions and contextual factors identified as optimal for Lesson Study to successfully support curriculum enactment [See sub-section 4.5.3], the extent to which the education system in Ireland is structured to allow for the conditions necessary for Lesson Study to be effective requires further consideration. Importantly, Seleznyov (2019) also warns that Lesson Study is not proposed as a quick shot solution to curriculum reform. Rather, it is with continuous engagement in Lesson Study, and over time, that practices can be internalised and integrated into teachers' existing practices and attitudes (Garet et al., 2001). Stigler and Hiebert (1999) assure that, approached in this way, Lesson Study can empower individual teachers and lead to steady incremental improvement in teaching. Notwithstanding, this raises an inevitable question as to how impactful Lesson Study might be without sustained system or policy support for its implementation.

6.2.2 Implications of findings for practice

In practical terms, the refined programme theory outlines an established pathway for supporting the enactment of the new primary mathematics curriculum, albeit specifically in terms of the research theme selected by the participating teachers in the study, namely the development of children's understanding of Place Value and their adaptive reasoning skills. Nevertheless, the TDE framework and development of the programme theory outlined in this study offers a practical model for evaluating PD for enacting other aspects of the new primary curriculum that may be considered more relevant to other researchers or schools. Indeed, this framework and the exemplification of how TDE was employed in this evaluation study may serve as a useful example for the evaluation of PD at a broader level. This methodology adopted may hold particular significance or relevance for researchers who seek to determine not simply why a PD or intervention works (or not), but also how and why it does so. In addition to the methodology employed, a number of findings from

the research study also have significance and give credence to the applicability of Lesson Study to close the curriculum implementation gap in practical terms.

In addition to primary curriculum reform, a plethora of other new education policies have been introduced to schools in recent years (DES, 2011, 2012, 2016; Teaching Council, 2016, 2017). These new policies collectively presuppose new perspectives of teacher professionalism in Ireland which has implications for teachers' professional norms and identities (Wallace and Priestley, 2011). It was interesting then to find that through Lesson Study, teachers reported re-negotiating how they thought about themselves as professionals and their role in teaching the new curriculum. As predicted by Fullan and Hargreaves (2016), it was Lesson Study activities such as studying, planning and working collaboratively with peers that were reported to mobilise and orient teachers to shift their perspectives of their roles as teachers. Importantly, teachers' descriptions of their roles when teaching the Research Lessons align favourably with the vision for teaching the new primary mathematics curriculum (Dunphy et al., 2014). Likewise, the pedagogical approaches and learning experiences which were evident in Research Lesson strongly reflect the vision for children's learning with the new primary mathematics curriculum (Dooley, 2019). As a result, the findings give further confidence for the potential for Lesson Study to support enactment of the new curriculum in practice.

In addition, it has been argued that owing to the historical culture of top-down education reforms in Ireland, Irish teachers may lack the professional capacity or confidence to enact new curriculum changes (Gleeson, 2010, 2012). Previous reform efforts were also noted as having the potential to weaken the resolve of teachers and schools to independently manage and embrace curriculum change (Murchan et al., 2009). With these apprehensions in mind, it was promising to find that engagement in Lesson Study was described by many of the participating teachers as energising, motivating and empowering; and reportedly gave teachers confidence in their capacity to teach the new primary mathematics curriculum. Overall, findings from this study are promising in terms of supporting teachers to meaningfully engaged with, manage and enact imminent primary curriculum changes in practical terms.

Finally, as another potential finding of significance for practice, the learning theory which underpins the new primary mathematics curriculum has a strong emphasis on the social construction of knowledge and understanding [see sub-section 2.3.4]. Correspondingly, Lesson Study is a collaborative process where teacher's professional learning and practices

are socially constructed (Rock and Wilson, 2005). The research findings suggest that by engaging teachers in a professional learning and development experience that was congruent with the learning experiences that children have when learning mathematics (with the new curriculum), Lesson Study was found to provide a professional learning and development space where teachers tacit understanding of teaching and learning mathematics could better align with curriculum policy aspirations, and as a result, directly translate to the lived curriculum experience of the children.

6.3 Contribution to knowledge

This research study generated new and substantive evidence to reinforce existing studies which attest to the merit of Lesson Study as an effective model of PD (Cavey and Berenson, 2005; Hart, 2009; Lewis, Perry and Hurd, 2009; Matthews et al., 2009; Perry and Lewis, 2011; Suh and Fulginiti, 2011); and as a tool for supporting curriculum reform (Lewis and Tsuchida, 1997; Stigler and Hiebert, 1999; Lewis, 2010; Fan Yang, 2013; Lewis and Takahashi, 2013; Olander and Sandberg, 2013; Takahashi et al., 2013; Tan-Chia et al., 2013). In terms of specific contributions to the literature, empirical findings on the impact of Lesson Study show that as a result of engaging in Lesson Study, positive outcomes were found across all five critical levels of PD evaluation, namely in terms of teacher reactions, acquisition of new knowledge and skills, organisational change and support, use of new knowledge and skills, and children's learning. These new findings can now be added to the growing research base in Ireland which demonstrates Lesson Study's effectiveness to enhance teaching and learning (Corcoran, 2011b; Leavy and Hourigan, 2016) and catalyse curriculum reform (Ní Shúilleabháin and Seery, 2017) in the Irish context. Importantly, these findings also provide previously unknown explanations as to why Lesson Study was effective to support curriculum enactment in this specific context.

In addition, analysis of findings generated to evaluate the Theory of Action or test model of Lesson Study employed in the study showed that the conditions and context for implementing Lesson Study in this study largely align with, and thus, confirm contemporary theories of effective and meaningful PD. In producing a refined programme theory, in particular a tested and refined model of Lesson Study for the Irish primary context, the study also generated an important output and contribution to theory that can be incorporated into the existing body of theoretical knowledge. Kennedy (2014) proposes that the generation of theory about teacher PD will help us to better understand policy and

consequently impact positively on practice. This refined model of Lesson Study may thus be of particular interest and use to policy makers or CPD providers, and / or, also perhaps stimulate further testing, evaluation, research and investigation in the Irish context. Furthermore, given the importance placed on embedding evaluation in professional development [See sub-section 5.4], this refined programme theory might also serve as a useful starting point or theoretical tool for evaluation researchers or school leaders who wish to conduct an evaluation of Lesson Study in their own bespoke context or setting.

Finally, from reviewing the literature, it is evident that TDE is an underused research methodology for the evaluation of teacher professional development. In this research study, TDE was found to successfully facilitate the generation of comprehensive empirical data upon which to make claims about the merit of Lesson Study to support enactment of the new primary mathematics curriculum. Moreover, it received favourable reviews from teachers participating in this study who reported greater levels of interest in, input towards and ownership over the evaluation process. As such, the employment of TDE in this study may provide scope or impetus for education researchers to adopt this relatively novel research methodology in their own evaluation research studies.

In summary, this study has contributed to the knowledge base in four distinct ways. Firstly, this study evaluated Lesson Study in a novel context, specifically as a model of PD to support enactment of a new primary mathematics curriculum in Ireland. Secondly, in addition to self-reported outcomes, the evaluation also provides new empirical evidence of the impact of Lesson Study, as well as explicating the determinants or causal factors which were more or less responsible for these findings. Thirdly, the generation of a refined programme theory which details the conditions and context for Lesson Study to be effective in Irish primary schools, offers an important output in terms of introducing new theory into the field. Lastly, the adoption and evaluation of TDE in this study, a relatively novel methodology in education research, offers a new perspective for researchers in terms of evaluating PD programmes in a way that aligns strongly with contemporary agendas of teacher professionalism, and professional learning and development.

6.3.1 Limitations to generalisation

In the literature, there is widespread criticism in the ability of case studies to produce generalisable data (Yin, 1994). However, Herriott and Firestone (1983) argue that multi-site case studies, such as used in this research, provides for a greater level of description and

generalisability than single-case studies. These authors suggest that by focusing on the same issues in a number of settings, 'radical particularism' can be avoided. However, they caution that differences in site structures and practices need to be taken into consideration when conducting cross-site comparisons, as discrepancies could limit the accuracy of claims and also contribute to researcher bias. Gerring (2007) holds that sample representativeness is essential for good external validity. Given that the main differentiating variable among schools was school size [See sub-section 3.2.2], there may have been other extraneous variables which call into question the representativeness of the schools recruited to participate in the study. The standardised methodology and application of identical research protocols across each research site, and the transparent nature of the evaluation approach adopted in the study (TDE) served to minimise these risks. However, notwithstanding Jacobsen's (2002) claim that multi-site case studies are the perfect balance between generalisability and data relevancy, it is important that the reader is mindful of these possible limitations.

While there is a view held that external validity is of foremost importance in evaluation research (Cronbach, 1982), it was also an imperative of the research, particularly given the researchers professional role [see section 1.3], to respond directly to stakeholder's views and needs (Guba and Lincoln, 1981). As outlined in detail in sub-section 3.3.1, theory-driven evaluation aims to optimise and balance both internal and external validities, and in doing so, provided for an evaluation of Lesson Study that addressed both scientific and stakeholder credibility [See sub-section 2.5.4]. Given the researchers professional role, the researcher was especially careful to avoid biasing the research and / or generate data that might be considered what the researcher 'wants to find' (Gillham, 2000). In this research, the programme theory or framework for evaluating Lesson Study was generated by teachers themselves, based on their assumptions and implicitly held views [See section 3.4]. The researcher aimed to fully adhere to principles of integrity, internal scrutiny, honest detachment and decentring (Gillham, 2000) in drawing conclusion from the findings. Given that sample randomisation or the inclusion of a control group was not feasible, these conclusions were drawn conservatively and in the context of substantive evidence generated in the study. It is also important to note that despite being strongly defended in the methodology chapter [See sub-section 3.5.1], the research evaluation relied heavily on the use of self-report data. When considering the findings, it would be remiss not to signal that weaknesses and limitations of self-report data have also been highlighted in the literature (Cook and Campbell, 1979; Paulhus and Vazire, 2007).

6.3.2 Implications for further study

In addition to contributing to the research base, this study produced knowledge that might serve to inform or connect further research, as well as focus unanswered future research questions. New questions arising from the findings may become the impetus for further research studies. In particular a number of self-reported findings from the TDE evaluation of Lesson Study raised potential areas of focus for further investigation.

Given that teachers reported changes in how they thought about their professional roles as teachers and were observed to adopt a less didactic role in Research Lessons, it may be beneficial to explore in greater detail the impact of Lesson Study on teacher identity, particularly in the context of radical curriculum reform and change. Furthermore, analysis of the evaluation findings highlighted the centrality and importance of quality relationships to allow for successful collaborations among teachers. Given the prominence afforded to teacher collaboration for professional learning and development, as well as for embedded curriculum change in practice, more research would be useful to determine the cause and effect between teacher relationships and Lesson Study collaborations.

On analysing the correlations between findings in the study a number of intuitive and natural links were made. To better understand and make definitive claims about these associations, further research studies would be necessary. For example, research findings implied a link between the focused and purposeful development of children's adaptive reasoning skills and teachers' use of open-ended questioning. They also implied a link between the children's increased openness and receptiveness to different teaching styles and their response to differentiated instruction. Also, in the study, the identification of 'teachable moments' was strongly attributed to the teachers' provision of inclusive and differentiated learning experiences. However, further research would be needed to conclusively assert this finding.

Objective measures of impact show that changes to teachers' practice and children's learning largely sustained four to six months following the intervention. However, longitudinal studies of the impact of Lesson Study on these areas would be needed to make assertions as to how abiding teachers' engagement with Lesson Study was for teaching and learning in these specific areas. Despite the generation of findings within the timeline for data collection, it might also be argued that repeat investigations of self-report measures of impact would serve to strengthen the reliability of some findings. For example, repeat

measures could be used to verify that teachers increased capacity to meet the demands of the new curriculum as well as improvements to their knowledge for teaching primary mathematics occurred as a result of engaging in Lesson Study. Whilst not required to complete this study, further evaluations of Lesson Study and investigation of these identified gaps in the findings might serve to confirm, build on and / or enrich conclusions drawn from this research study. As such, this study many serve as an important starting point for more in-depth studies of Lesson Study in the Irish primary context.

Finally, in terms of evaluating Lesson Study in the context of curriculum enactment at primary level in Ireland, Cook and Fine (1997) suggest that evaluation ought to be an ongoing process that is initiated in the initial stages of PD planning, continued during the professional learning and implementation process, and sustained beyond programme completion. As such, it might be useful to conduct a more lengthy and extensive evaluation of Lesson Study that spans across and beyond the curriculum publication, PD and implementation period. Notwithstanding the success of Lesson Study in the context of the case schools, the question remains as to whether Lesson Study would be as successful to support the enactment of the primary mathematics curriculum in other schools' contexts, particularly those with more diverse school populations than the case schools who participated in this study. Given the paucity of research in this area, there is also large scope to research and evaluate the merit of Lesson Study to support enactment of curriculum in other areas of learning (with different theoretical underpinnings). Given the size of the research sample, larger scale evaluation studies would be beneficial to fortify the external validity and generalisability of findings generated in this study. Furthermore, to test the generalisability of the refined programme theory, this refined theory could be adopted and used to evaluate lesson Study in different settings, with varying profiles of teachers, and with a larger sample.

6.4 Final thoughts

The gap between intended and enacted curriculum exists and is a very real problem for education systems worldwide to address, not least in Ireland. Many lessons have been learned from past reviews and evaluations of primary curriculum implementation in Ireland and it is incumbent on stakeholders of education to ensure that past mistakes are not repeated. The reality of embedding policy aspirations and curriculum change in teachers' practice and the lived experiences of children is complex and multi-layered. However, it is

clear that to close the gap between intended and enacted curriculum and realise curriculum in real and meaningful ways, new curriculum need to be attended by considered, deliberate and evidence-based models and approaches to PD. Teachers are best placed to determine what their professional learning and development needs for enacting new curriculum are. In a time when teacher agency and professionalism are increasingly valued and upheld in our education system, it holds that teachers ought to be trusted to shape their own professional learning and development experiences to best meet their needs, as well as have inputs into the evaluation of these experiences.

Over the coming years, a suite of new primary curriculum specifications will be introduced to schools, the first of which will be a new mathematics curriculum. Whilst the research study shows that Lesson Study holds strong potential as a model of PD to support enactment of this new curriculum; to provide relevant and useful insights for policy-makers, CPD providers, school leaders and teachers, it is perhaps more important that this study elucidated how, in what ways and why Lesson Study demonstrates its merit in this regard. As such, this study helped to bring to light some of the implicit challenges and opportunities for supporting curriculum enactment that would otherwise remain vague and unknown. In doing so, it is hoped that this study can offer relevant and timely insights for supporting the new curriculum to be realised in practice.

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Appendices

Appendix 1. Information, ethics briefing and consent

Lesson Study PhD Research Study

Information and Consent

Introduction

My name is Tracy Curran, I am an Education Officer with the NCCA and a PhD candidate with the University of Lincoln, UK. I have taught in mainstream primary schools for many years before taking a secondment opportunity to work in the area of curriculum development. I have a deep passion for quality teaching and learning in classrooms, a strong belief that teachers are best placed to make decisions about their own professional learning and development, and a firm appreciation for how powerful PD can be when it is done well.

Research rationale

In 2019, the new primary mathematics curriculum is to be published by the NCCA. Following publication of the curriculum, in-service will be provided to teachers to support them to enact the new curriculum. What this in-service will look like is yet to be decided. Given the significant changes proposed in the new curriculum in terms of how we think about how children learn, teachers will require appropriate supports to enable them to enact the curriculum as intended.

Lesson Study is a model of PD which is gaining increasing credibility worldwide as an effective means to support teachers to enact change and adopt new practices in their classroom. The authors of the research reports underpinning the new mathematics curriculum (Executive Summary, NCCA, 2014, 15) have stated:

> *"Educators need to be given opportunities to interrogate and negotiate the redeveloped curriculum with colleagues as it relates to their setting and context. Time needs to be made available to educators to engage in collaborative practices such as Lesson Study".*

Aim of the research

The aim of my research study is to inform policy and decision-making as to the type of in-service which teachers believe is required for them to enact the new curriculum in a meaningful way and in a way that is helpful to them. Given the credibility afforded to Lesson Study as a curriculum reform tool in other countries (mainly Japan, US, Singapore, UK, China) and also the use of Lesson Study as the primary in-service model to support the new Senior Cycle Maths curriculum (formerly Project Maths), the potential for Lesson Study

to support primary school teachers to enact the new primary mathematics curriculum merits further investigation.

Key research question

The key question underpinning the research study I am conducting is:

Is Lesson Study an effective means to support Irish teachers to enact the new primary mathematics curriculum? How and why is this the case?

How will the research be conducted?

Using a case study approach, Lesson Study will be implemented and evaluated in three different school contexts (1) a large school with multiple classes at the same level, (2) a medium school with single classes at the same level, and (3) a small school with multi-grade classes. A Lesson Study (LS) Intervention team from each school (with a minimum of three teachers on each team, ideally who teach in the junior classes – infants to second class) will engage in 3 cycles of Lesson Study to support them to enact the new primary mathematics curriculum (currently in draft format and at consultation stage of development). Over 6 days (across a four-month period), LS Intervention teams will be supported by the researcher (as facilitator) to

a) Familiarise them with the key messages underpinning the new primary mathematics curriculum.
b) Familiarise and support them as to how Lesson Study works at school level.
c) Develop an evaluation framework to determine what outcomes and conditions teachers themselves deem necessary to occur in order to determine that Lesson Study was successful in supporting them to enact the new curriculum.
d) Plan for, teacher, observe (live lessons) and reflect on three Research Lessons designed to support teachers to bring the curriculum to life in their classrooms.
e) Evaluate the success of the intervention programme for their own professional development and learning.

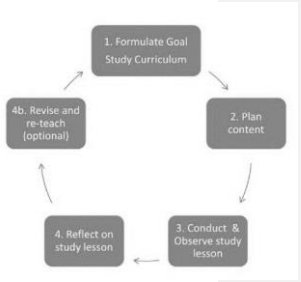
A new primary mathematics curriculum is in development

Mathematics has largely remained unchanged since the 1999 primary mathematics curriculum was introduced to schools. What has changed in our understanding of how children learn and become mathematically proficient. Research, national assessments and evaluations of curriculum implementation from the past 15 years has pointed to the need for a new approach to teaching and learning in mathematics. This new approach presents huge opportunities for children's learning but also potential challenges for teachers in adapting to this new approach. To enact the curriculum as intended, in-service to attend the new curriculum will need to provide appropriate space to teachers to allow them to internalise the key messages underpinning the new curriculum and put these changes into practice in their own settings (NCCA, 2016).

What is Lesson Study?

Lesson Study is a model of professional development with its origins in Japan. Central to Lesson Study are teachers working collaboratively on the process of professional development and learning. It has been described as a collaborative tool for analysing and developing understanding of children's learning; and for capturing and interrogating new and critical insights into teaching and learning (Wood and Cajkler, 2017). It has also been described as a systematic investigation of classroom pedagogy, conducted by teachers themselves, with the expressed aim of improving the quality of teaching and learning (Tsui and Law 2007).

At the core of Lesson Study is a clear research purpose or area of professional learning and development which teachers wish to investigate for their own practice. Teachers study curriculum and work collaboratively to plan for and teach a series of 'Research Lessons'. These 'Research Lessons' are taught in the presence of the LS team (each intervention team member takes a turn to teach) and team members observe children's learning in the lesson for significant points of reflection. Teachers then share their learning (the results of their research/investigation) and the cycle continues. A typical Lesson Study cycle involves the following steps as outlined in the figure (Lewis and Hurd, 2009).



Lesson Study has been found to have a statistically significant positive impact on children's learning outcomes and on their mathematical proficiency in particular (Lewis and Hurd, 2017). It is now widely used as a primary model of professional development in countries such as Japan, Singapore, China, the US and the UK. In Ireland, Lesson Study is currently used in universities with teachers at pre-service level and at a widespread level at Post-Primary to support the enactment of the Senior Cycle mathematics syllabus (Brosnan, 2014). As yet, there has been no scientific investigation of Lesson Study at primary level to support the enactment of primary curriculum.

Within the literature, Lesson Study demonstrates strong potential to enable teachers to adopt change in terms of their practice and values teaching, teachers and the professional teaching community as central to the change process. To do so, Lesson Study builds a shared knowledge base for teaching that can be tested and refined and importantly, fosters teacher's intrinsic motivation to continue to improve their own teaching and that of colleagues (Lewis and Hurd, 2011)

What does involvement in the research study entail.

A minimum of three teachers from each school (ideally who are currently teaching junior infants, senior infants, 1st or 2nd class and/or Learning Support) to form a Lesson Study Intervention Team. Teachers will be asked to attend two days of CPD at a central venue (Likely local Education Centre) in March before the Easter break. Teachers will then be

asked to conduct three cycles of Lesson Study in their schools, one a month in April, May and June. Finally, teachers will be asked to attend a final day of data collection at a central venue in June upon completion of the intervention.

- March – two days in local Education Centre
- April – one day in-school
- May – one day in-school
- June – one day in-school
- June – one day in local Education Centre

What am I offering to each school for participating in the study?

- Nine days of substitute cover (which can be used any way that the school wishes)
- €1000 grant per school
- Continual support for teachers participating throughout the study

Do teachers have to take part?

No, taking part is voluntary. If you would prefer not to take part, you do not have to give a reason. If you decide to take part, I will ask you to provide signed informed consent prior to taking part. You are free to withdraw from the study at any time, without giving a reason.

What are the possible risks and benefits from taking part?

I cannot promise that taking part will benefit you directly. By taking part you will contribute to the literature and research base that may help to inform policy and decision making as to the model of professional development that will attend the new primary mathematics curriculum. I do not plan to research any sensitive or invasive issues. However, if you feel uncomfortable during the study, you will be free to withdraw from the study at any time, without giving a reason.

Will my taking part in this study be kept confidential?

Yes. The identity of people taking part in the study will only be known to the researcher and to fellow participants. Schools participating will not be identified without prior consent from said schools.

Will the information I provide remain confidential?

Yes. Any information you provide will remain confidential and anonymised. Your information will be securely stored by the researcher according to University of Lincoln Code of Research Ethics.

What will happen to the results of the study?

The findings from this study will be presented and discussed as part of my PhD research thesis and this may be published in a scientific journal or presented at a conference. However, your identity will remain anonymous in all publications and presentations of the findings.

Who is organising and funding the research?

The study is organised and carried out by the researcher Tracy Curran as part fulfilment of a PhD academic award. The study is partially funded by the National Council for Curriculum and Assessment (NCCA) and also partially self-funded.

Where can I get more information?

If you require further information about the study you can contact Tracy Curran on XXXXXXXXXX or by email to xxxxx.xxxxxx@xxxxxx.xxx for further information.

Ethics and Informed Consent

From the oral briefing provided at the Initial Research meeting Tuesday 13th March, I understand/am aware of:

- ✓ The nature of the study, research questions and aims of the study have been explained clearly
- ✓ My participation in this study is voluntary with no obligation to participate and full right to withdraw at any stage of the study
- ✓ My role in participating in the study has been outlined
- ✓ The provision of the grant of €1000 per school is provided on condition that three teachers from each school participate and complete the study. If I cease to participate in the study, my principal will be invited to nominate a replacement teacher. This does not impact my right to withdraw at any stage
- ✓ The role of the researcher in the study has been outlined and I am satisfied that there is no conflict of interest between the role of the researcher as curriculum developer and as researcher/evaluator in the context of this study. I am in no way obliged or encouraged to report positively about my experiences and/or of curriculum materials provided
- ✓ I am in no way compelled or encouraged to put forward views that do not reflect my genuine opinion. The full honesty and transparency of my views are central to the rigour of the findings

- ✓ The anonymity of data among the participants cannot be guaranteed due to the nature of the study but all findings will be anonymised in the presentation and/or publication of findings
- ✓ Data pertaining to children, collected by participants as artefacts during the study, should be appropriately anonymised and coded
- ✓ Research data and artefacts will be stored securely, and password protected. Data may be identifiable to you but will be coded so that this will not be identifiable outside of the participant group

By signing my consent:

- ❖ I give permission for data generated by me as part of the study to be used in the presentation of findings
- ❖ I give permission for audio and video footage containing my image and voice, collected over the course of the study, to be used as part of the research findings
- ❖ I give permission for audio and video footage containing my image and voice, collected over the course of the study, to be used for purposes beyond the study e.g. in providing exemplification of different aspects of Lesson Study in professional development courses and/or presentations. If you give your consent, but change your mind at a later stage, you have the right to withdraw your consent by notifying the researcher

Signature of participant: _____ Date: _____

Signature of researcher: _____ Date: _____

Appendix 2. Teacher questioning, by teacher and overall

The following table provides a breakdown of number of eligible questions for evaluation, further coded and broken down into five categories (AI, AC, AE, AF, AFO). Included in this table are lesson durations and the frequencies of open-ended questions posed by teachers (For example, Sandra asked one open-ended question every 4 minutes and 42 seconds in the Pre-Lesson Study recording).

Teacher		No. of eligible Qs*	Closed Questions		Open Questions			Lesson Duration in Hrs:mins:secs	Frequency of open-ended question in mins:secs
			AI	AC	AE	AF	AFO		
Sandra	Pre-Lesson Study: Number of Qs		15	14	5	0	0	23:30	4:42
	Pre-Lesson Study: Proportion of Qs	34	44.1%	41.2%	14.7%	0%	0%		
	Research Lesson : Number of Qs		11	6	21	2	4	32:05	1:11
	Research Lesson : Proportion of Qs	44	25%	13.6%	47.7%	4.6%	9.1%		
	Post- Lesson Study (1m) : Number of Qs		16	9	22	5	6	35:51	1:05
	Post- Lesson Study (1m) : Proportion of Qs	58	27.6%	15.5%	37.9%	8.6%	10.4%		
	Post- Lesson Study (4-6m) : Number of Qs	N/A Teacher retired							
	Post- Lesson Study (4-6m) : Proportion of Qs								
Selena	Pre-Lesson Study: Number of Qs		15	7	5	0	0	18:29	3:36
	Pre-Lesson Study: Proportion of Qs	27	55.6%	25.9%	18.5%	0%	0%		
	Research Lesson : Number of Qs		15	9	20	3	5	44:06	1:34
	Research Lesson : Proportion of Qs	52	28.8%	17.3%	38.5%	5.8%	9.6%		
	Post- Lesson Study (1m) : Number of Qs		10	2	21	0	1	23:21	1:03
	Post- Lesson Study (1m) : Proportion of Qs	34	29.4%	5.9%	61.8%	0%	2.9%		
	Post- Lesson Study (4-6m) : Number of Qs		9	7	12	3	4	34:26	1:48

	Post- Lesson Study (4-6m) : Proportion of Qs	35	25.7%	20%	34.3%	8.6%	11.4%		
Sonya	Pre-Lesson Study: Number of Qs	52	16	15	12	8	1	23:35	1:07
	Pre-Lesson Study: Proportion of Qs		30.8%	28.9%	23.1%	15.4%	1.8%		
	Research Lesson : Number of Qs	41	8	10	17	3	3	25:14	1:05
	Research Lesson : Proportion of Qs		19.5%	24.4%	41.5%	7.3%	7.6%		
	Post- Lesson Study (1m) : Number of Qs	54	10	9	32	2	1	19:25	0:32
	Post- Lesson Study (1m) : Proportion of Qs		18.5%	16.7%	59.3%	3.7%	1.8%		
	Post- Lesson Study (4-6m) : Number of Qs	49	15	4	28	0	2	19:21	0:38
	Post- Lesson Study (4-6m) : Proportion of Qs		30.6%	8.2%	57.1%	0%	4.1%		
Maria	Pre-Lesson Study: Number of Qs	38	20	8	8	2	0	23:39	2:21
	Pre-Lesson Study: Proportion of Qs		52.6%	21.1%	21.1%	5.2%	0%		
	Research Lesson : Number of Qs	48	14	11	16	3	4	38:56	1:41
	Research Lesson : Proportion of Qs		29.2%	22.9%	33.3%	6.3%	8.3%		
	Post- Lesson Study (1m) : Number of Qs	32	8	2	20	1	1	24:02	1:05
	Post- Lesson Study (1m) : Proportion of Qs		25%	6.3%	62.5%	3.1%	3.1%		
	Post- Lesson Study (4-6m) : Number of Qs	35	12	4	18	0	1	30:54	1:37
	Post- Lesson Study (4-6m) : Proportion of Qs		34.3%	11.4%	51.4%	0%	2.9%		
Megan	Pre-Lesson Study: Number of Qs	39	22	7	10	0	0	24:04	2:24
	Pre-Lesson Study: Proportion of Qs		56.4%	17.9%	25.7%	0%	0%		
	Research Lesson : Number of Qs	53	15	10	24	3	1	41:10	1:28
	Research Lesson : Proportion of Qs		28.2%	18.9%	45.3%	5.7%	1.9%		
	Post- Lesson Study (1m) : Number of Qs	33	12	7	9	1	4	18:57	1:21
	Post- Lesson Study (1m) : Proportion of Qs		36.4%	21.2%	27.3%	3%	12.1%		
	Post- Lesson Study (4-6m) : Number of Qs	42	10	8	21	3	0	21:23	0:53
	Post- Lesson Study (4-6m) : Proportion of Qs		23.8%	19%	50%	7.2%	0%		

Molly	Pre-Lesson Study: Number of Qs	26	11	9	6	0	0	14:58	2:29
	Pre-Lesson Study: Proportion of Qs		42.3%	34.6%	23.1%	0%	0%		
	Research Lesson : Number of Qs	48	13	5	24	2	4	47:04	1:34
	Research Lesson : Proportion of Qs		27.1%	10.4%	50%	4.2%	8.3%		
	Post- Lesson Study (1m) : Number of Qs	47	13	7	20	3	4	34:08	1:15
	Post- Lesson Study (1m) : Proportion of Qs		27.7%	14.9%	42.5%	6.4%	8.5%		
	Post- Lesson Study (4-6m) : Number of Qs	30	10	3	16	0	1	34:24	2:01
	Post- Lesson Study (4-6m) : Proportion of Qs		33.3%	10%	53.3%	0%	3.3%		
Lauren	Pre-Lesson Study: Number of Qs	88	61	16	10	1	0	29:39	2:41
	Pre-Lesson Study: Proportion of Qs		69.3%	18.2%	11.4%	1.1%	0%		
	Research Lesson : Number of Qs	63	26	12	21	3	1	36:18	1:27
	Research Lesson : Proportion of Qs		41.3%	19%	33.3%	4.8%	1.6%		
	Post- Lesson Study (1m) : Number of Qs	41	12	6	20	2	1	19:42	0:51
	Post- Lesson Study (1m) : Proportion of Qs		29.3%	14.6%	48.8%	4.9%	2.4%		
	Post- Lesson Study (4-6m) : Number of Qs	46	12	8	17	6	3	19:42	0:45
	Post- Lesson Study (4-6m) : Proportion of Qs		26.1%	17.4%	37%	13%	6.5%		
Leah	Pre-Lesson Study: Number of Qs	30	14	4	9	0	3	20:24	1:42
	Pre-Lesson Study: Proportion of Qs		46.7%	13.3%	30%	0%	10%		
	Research Lesson : Number of Qs	49	9	13	22	2	3	37:11	1:22
	Research Lesson : Proportion of Qs		18.4%	26.5%	44.9%	4.1%	6.1%		
	Post- Lesson Study (1m) : Number of Qs	50	15	9	20	3	3	40:46	1:34
	Post- Lesson Study (1m) : Proportion of Qs		30%	18%	40%	6%	6%		
	Post- Lesson Study (4-6m) : Number of Qs	50	14	11	18	3	4	33:16	1:19
	Post- Lesson Study (4-6m) : Proportion of Qs		28%	22%	36%	6%	8%		
	Pre-Lesson Study: Number of Qs		15	15	12	2	1	21:35	1:26

Lorraine	Pre-Lesson Study: Proportion of Qs	45	33.3%	33.3%	26.6%	4.5%	2.3%		
	Research Lesson : Number of Qs		15	10	24	3	2	34:50	1:12
	Research Lesson : Proportion of Qs	54	27.8%	18.5%	44.4%	5.6%	3.7%		
	Post- Lesson Study (1m) : Number of Qs		7	10	25	3	3	20:41	0:40
	Post- Lesson Study (1m) : Proportion of Qs	48	14.6%	20.7%	52.1%	6.3%	6.3%		
	Post- Lesson Study (4-6m) : Number of Qs		10	8	18	2	3	32:14	1:24
	Pre-Lesson Study: Number of Qs	41	24.4%	19.5%	43.9%	4.9%	7.3%		
Overall	Pre-Lesson Study: Number of Qs		189	95	77	13	5	3:19:53	2:06
	Pre-Lesson Study: Proportion of Qs	379	49.9%	25.1%	20.3%	3.4%	1.3%		
	Research Lesson : Number of Qs		126	86	189	24	27	5:36:53	1:24
	Research Lesson : Proportion of Qs	452	27.9%	19.0%	41.8%	5.3%	6.0%		
	Post- Lesson Study (1m) : Number of Qs		103	61	189	20	24	3:56:53	1:01
	Post- Lesson Study (1m) : Proportion of Qs	397	26.0%	15.4%	47.6%	5.0%	6.0%		
	Post- Lesson Study (4-6m) : Number of Qs		92	53	148	17	18	3:44:20	1:14
	Post- Lesson Study (4-6m) : Proportion of Qs	328	28.0%	16.2%	45.1%	5.2%	5.5%		

*Eligible Qs refer to questions that were categorised as open or closed questions. Managerial or rhetorical questions were omitted from this selection.

Appendix 3. Children's Place Value assessment scores, by school and overall

	Place Value Assessment Criteria		**Small School Scores**	Small School Average / 10	**Medium School Scores**	Medium School Average / 24	**Large School Scores**	Large School Average / 18	**Overall Scores per criteria**	Overall Average per criteria /52
1	Appreciates that the position of a digit indicates its value – that digits to the left have the greatest value, digits to the right have the least	**Pre-**	**5**	0.5	**6**	0.25	**17**	0.95	**28**	0.54
		Post-	**16**	1.6	**35**	1.46	**24**	1.3	**75**	1.44
2	Can model and represent the value of a number (between 11-19) to communicate the idea of tens and units	**Pre-**	**7**	0.7	**3**	0.13	**10**	0.56	**20**	0.38
		Post-	**16**	1.6	**32**	1.3	**15**	0.83	**63**	1.21
3	Can identify and write the number that is 1 more, 1 less, 10 more than a number (between 11-19)	**Pre-**	**10**	1	**18**	0.75	**23**	1.28	**51**	0.98
		Post-	**13**	1.3	**22**	0.92	**25**	1.39	**60**	1.15
4	Can compose and decompose a number (between 11 -19) into tens and units	**Pre-**	**16**	1.6	**10**	0.42	**9**	0.5	**35**	0.67
		Post-	**18**	1.8	**20**	0.83	**14**	0.78	**52**	1
	Overall scores per school	**Pre-**	38	3.8	**37**	1.54	**59**	3.28	**134**	2.57
		Post-	**63**	6.3	**109**	4.54	**78**	4.33	**250**	4.80

Pre/Post Assessment Score Differences

Score	**+25**	+2.5	**+72**	+3	**+19**	+1.05	**+116**	+2.23
%		**+31.3%**		**+37.5%**		**+13.1%**		**+27.9%**

Appendix 4. Children's Reasoning Skills assessment scores, by school and overall

	Reasoning Skills Assessment Criteria		**Small School** **Scores**	Small School Average / 10	**Medium School** **Scores**	Medium School Average / 24	**Large School** **Scores**	Large School Average / 18	**Overall Scores per criteria**	Overall Average per criteria /52
1	The child can explain why they chose a particular number, strategy or solution to justify their answer	**Pre-**	**4**	0.4	**9**	0.38	**5**	0.28	**28**	0.54
		Post-	**15**	1.5	**30**	1.25	**20**	1.11	**75**	1.44
2	The child can justify their solutions with plausible reasons	**Pre-**	**5**	0.5	**9**	0.38	**2**	0.11	**20**	0.38
		Post-	**14**	1.4	**29**	1.21	**19**	1.06	**63**	1.21
3	The child can think logically about the relationship between different representations of a number using Place Value concepts.	**Pre-**	**2**	0.2	**6**	0.25	**6**	0.33	**51**	0.98
		Post-	**10**	1	**15**	0.63	**12**	0.67	**60**	1.15
	Overall scores per school	**Pre-**	**11**	1.1	**24**	1	**13**	0.72	**134**	2.57
		Post-	**39**	3.9	**74**	3.08	**51**	2.83	**250**	4.80
	Pre/Post Assessment Score Differences	**Score**	**+28**	+2.8	**+50**	2.08	**38**	+2.11	**+116**	+2.23
		%		**+46.7%**		**+34.7%**		**35.2%**		**+37.2%**

Appendix 5. Statistical Testing of children's understanding of Place Value and reasoning skills

Paired Samples T-Tests

Overall Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1 (Place Value)	PV_Post_Total	4.81	52	2.105	.292
	PV_Pre_Total	2.52	52	1.915	.266
Pair 2 (Reasoning)	R_Post_Total	3.15	52	1.564	.217
	R_Pre_Total	.92	52	1.100	.153

Overall Paired Samples Correlations

		N	Correlation	Sig.
Pair 1 (Place Value)	PV_Post_Total & PV_Pre_Total	52	.560	.000
Pair 2 (Reasoning)	R_Post_Total & R_Pre_Total	52	.623	.000

Overall Paired Samples Test and Differences

		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	95% Confidence Interval of the Difference Upper	t	df	Sig. (2-tailed)
Pair 1 (Place Value)	PV_Post_Total - PV_Pre_Total	2.288	1.893	.262	1.762	2.815	8.720	51	.000
Pair 2 (Reasoning)	R_Post_Total - R_Pre_Total	2.231	1.231	.171	1.888	2.573	13.072	51	.000

Paired Samples Statistics, by school

			Mean	N	Std. Deviation	Std. Error Mean
Small School (1) (10 children)	Pair 1	PV_Post_Total	6.30	.517	1.636	.517
		PV_Pre_Total	3.80	.467	1.476	.467
	Pair 2 (Reasoning)	R_Post_Total	3.90	.314	.994	.314
		R_Pre_Total	1.10	.379	1.197	.379
Medium School (2) (24 children)	Pair 1	PV_Post_Total	4.54	.489	2.395	.489
		PV_Pre_Total	1.54	.335	1.641	.335
	Pair 2 (Reasoning)	R_Post_Total	3.08	.345	1.692	.345
		R_Pre_Total	1.00	.248	1.216	.248

Large School (3) (18 children)	Pair 1	PV_Post_Total	4.33	.370	1.572	.370
		PV_Pre_Total	3.11	.442	1.875	.442
	Pair 2 (Reasoning)	R_Post_Total	2.83	.373	1.581	.373
		R_Pre_Total	.72	.211	.895	.211

Paired Samples Correlations, by school

				N	Correlation	Sig.
Small School (1) (10 children)	Pair 1	(Place Value)	PV_Post_Total & PV_Pre_Total	10	.672	.033
	Pair 2	(Reasoning)	R_Post_Total & R_Pre_Total	10	.849	.002
Medium School (2) (24 children)	Pair 1	(Place Value)	PV_Post_Total & PV_Pre_Total	24	.530	.008
	Pair 2	(Reasoning)	R_Post_Total & R_Pre_Total	24	.592	.002
Large School (3) (18 children)	Pair 1	(Place Value)	PV_Post_Total & PV_Pre_Total	18	.645	.004
	Pair 2	(Reasoning)	R_Post_Total & R_Pre_Total	18	.631	.005

Paired Samples Test, by school

			Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	95% Confidence Interval of the Difference Upper	t	df	Sig. (2-tailed)
Small School (1) (10 children)	Pair 1 (Place Value)	PV_Post_Total - PV_Pre_Total	2.500	1.269	.401	1.592	3.408	6.228	9	.000
	Pair 2 (Reasoning)	R_Post_Total - R_Pre_Total	2.800	.632	.200	2.348	3.252	14.000	9	.000
Medium School (2) (24 children)	Pair 1 (Place Value)	PV_Post_Total - PV_Pre_Total	3.000	2.064	.421	2.128	3.872	7.120	23	.000
	Pair 2 (Reasoning)	R_Post_Total - R_Pre_Total	2.083	1.381	.282	1.500	2.666	7.393	23	.000
Large School (3) (18 children)	Pair 1 (Place Value)	PV_Post_Total - PV_Pre_Total	1.222	1.478	.348	.487	1.957	3.510	17	.003
	Pair 2 (Reasoning)	R_Post_Total - R_Pre_Total	2.111	1.231	.290	1.499	2.723	7.274	17	.000

Effect Size Testing using Cohen's D

	Overall Differences	N	Stats	Interpretation
Place Value	Effect size for difference in Place Value scores between the pre-test and the post-test	52	Cohen's d = (2.52 - 4.81)／2.017238 = **1.135215**	Large effect size - Strong difference
Reasoning	Effect size for difference in Reasoning scores between the pre-test and the post-test	52	Cohen's d = (0.92 - 3.15)／1.349741= **1.652169**	Large effect size - Strong difference

		Differences by School	N	Stats	Interpretation
Place Value	Small School	Effect size for difference in Place Value scores between the pre-test and the post-test	10	Cohen's d = (3.8 - 6.3)／1.56205 = **1.600461**	Large effect size - Strong difference
	Medium School	Effect size for difference in Place Value scores between the pre-test and the post-test	24	Cohen's d = (1.54 - 4.54)／2.055432 = **1.459547**	Large effect size - Strong difference
	Large School	Effect size for difference in Place Value scores between the pre-test and the post-test	18	Cohen's d = (3.11 - 4.33)／1.73195 = **0.704408**	Medium effect size - Moderate to strong difference
Reasoning	Small School	Effect size for difference in Reasoning scores between the pre-test and the post-test	10	Cohen's d = (1.1 - 3.9)／1.100023 = **2.545402**	Large effect size - Strong difference

Medium School	Effect size for difference in Reasoning scores between the pre-test and the post-test	24	Cohen's d = (1 - 3.08)／1.473855 = **1.411265**	Large effect size - Strong difference
Large School	Effect size for difference in Reasoning scores between the pre-test and the post-test	18	Cohen's d = (0.72 - 2.83)／1.285768 = **1.641042**	Large effect size - Strong difference

Reliability Testing using Cronbach's Alpha

Place Value Case Processing Summary			N	%
Place Value Pre-Lesson Study	Cases	Valid	52	100.0
		Excluded[a]	0	.0
		Total	52	100.0
Place Value Post- Lesson Study	Cases	Valid	52	100.0
		Excluded[a]	0	.0
		Total	52	100.0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	N of items
.469	4

Reliability Statistics

Cronbach's Alpha	N of items
.577	4

Reasoning Case Processing Summary			N	%
Reasoning Pre-Lesson Study	Cases	Valid	52	100.0
		Excluded[a]	0	.0
		Total	52	100.0
Reasoning Post- Lesson Study	Cases	Valid	52	100.0
		Excluded[a]	0	.0
		Total	52	100.0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	N of items
.550	3

Reliability Statistics

Cronbach's Alpha	N of items
.532	3

Appendix 6. Children's responses to open-ended questions posed by teachers, by school and overall

		Simple Responses [S]		Explanations [E]		Self-Evaluation [SE]	
Small School (10 children)	**Pre**	**22**	73.33%	**5**	16.67%	**3**	10%
	Post	**2**	6.67%	**22**	73.33%	**6**	20%
	Difference	**-20**	- 66.7%	**+17**	+56.7%	**+3**	+10.0%
Medium School (24 children)	**Pre**	**52**	72.22%	**19**	26.39%	**1**	1.39%
	Post	**22**	26.19%	**54**	64.29%	**8**	9.52%
	Difference	**-30**	- 46.0%	**+35**	+37.9%	**+7**	+8.1%
Large School (18 children)	**Pre**	**41**	75.93%	**13**	24.07%	**0**	0%
	Post	**17**	31.48%	**26**	48.15%	**11**	20.27%
	Difference	**-21**	-44.5%	**+13**	+24.1%	**+11**	+20.3%
Overall (52 children)	**Pre**	**115**	73.7%	**37**	23.7%	**4**	2.6%
	Post	**41**	24.4%	**102**	60.7%	**25**	14.9%
	Difference	**-74**	**-49.3%**	**+65**	**+37.0%**	**+19**	**+12.3%**

Appendix 7. Individual teacher surveys and testimonials

Small School			**Demographic:** Rural mixed-gender primary school. **No. of staff:** Four class teachers (including teaching principal) and one special education teacher (SET). **No. of children**: approx. 95 children.						
Code	**Pseudonym**	**Age range**	**Teach Exp in yrs.**	**Position**	**Disposition**	**Is LS effective?**	**Overall experience with LS**	**Most effective aspects of Lesson Study**	**Least effective aspects of Lesson Study**
1A	Sandra	50+	30+	Special Ed teacher	Enjoys, interested in and confident to teaching maths	Yes	Most enjoyable. Very informative. Positive and affirming experience.	Topics broken down into bitesize chunks. Working collaboratively and sharing ideas. Questioning and developing children's thinking skills. Observation of children's learning.	[left blank]
1B	Selena	30-39	10-15	Class teacher	Enjoys, interested in and confident to teaching maths but does find it difficult to teach.	Yes	Really enjoyed it. It's so valuable. Real quality approach to PD for teachers to learn from each other and bounce ideas.	Best approach to PD. Feel much more confident going forward. Planning together. Great to hear what another teacher saw in a lesson (something you might have missed).	None
1C	Sonya	40-49	15-20	Class teacher	Enjoys, interested in and confident to teaching	Yes	Very effective method. Very enjoyable. Enriching experience.	Allowed me to dissect what I actually wanted the children to learn. Opportunity to	[left blank]

					maths but does find it difficult to teach.		Working with colleagues was hugely beneficial.	really think about my questioning. Ensure more think time for children. Collaborative planning and post-RL discussions	
Medium School			**Demographic:** Suburban mixed-gender primary school. **No. of staff:** Eight class teachers, an administrative principal and two special education teachers (SET). **No. of children**: approx. 200 children.						
Code	**Pseudonym**	**Age range**	**Teach Exp in yrs.**	**Position**	**Disposition**	**Is LS effective?**	**Overall experience with LS**	**Most effective aspects of Lesson Study**	**Least effective aspects of Lesson Study**
2A	Maria	50+	30+	Class teacher	Enjoy, interested in and confident in teaching maths.	Yes	Positive, interesting, refreshing. Initially apprehensive about observation and nervous teaching in front of other teachers. Once understood Lesson Study, I relaxed and learned an enormous amount.	Time to engage with curriculum. Support, care and mutual respect from colleagues. Shared planning and evaluation of lessons. Individual observations of children.	Concern about how sustainable it would be outside of the study. Allocation of release time from classroom.
2B	Megan	30-39	5-10	Special Ed teacher	Enjoy and interested in maths. Some confidence issues with	Yes	Interesting and enjoyable. Gives space to look at various outcomes from a lesson.	Builds teacher confidence through support and collaboration. Time for reflections. Constructive observations. Post-lesson reflections.	I don't think any negative aspects. The benefits far outweigh the time required.

					teaching maths.		It has opened up my approach to teaching. I'm more open to collaboration. I improved my style of questioning.	Planning together. Listening to children's responses.	
2C	Molly	20-29	5-10	Class teacher	Enjoy and interested in maths. Some confidence issues with teaching maths.	Yes	Positive and beneficial. Engaging in focused discussion, sharing ideas and observations. Constructive feedback. Giving it a go. Working as part of team, giving/getting support.	Explore new curriculum in manageable chunks so not overwhelmed. Not pressure to fit into a certain box. Feedback and time. Peer support. Time to plan, prepare, reflect and feedback.	Dependent on support of other staff to allow time to plan. Will it continue after facilitator leaves?
Large School			**Demographic:** Urban girl's primary school. **No. of staff:** Thirteen class teachers, an administrative principal and four special education teachers (SET). **No. of children**: approx. 350 children.						
Code	**Pseudonym**	**Age range**	**Teach Exp in yrs.**	**Position**	**Disposition**	**Is LS effective?**	**Overall experience with LS**	**Most effective aspects of Lesson Study**	**Least effective aspects of Lesson Study**
3A	Lauren	20-29	5-10	Class teacher	Enjoys, interested in and confident to teaching maths. Not difficult.	Yes and no	Enjoyed parts involving the new curriculum and ways of improving it. It was very time consuming for just one curriculum topic/skill.	I'm more confident to push the boundaries set by 1999 curriculum and challenge kids with open questions and problem-solving. I learned a lot about how to teach the new curriculum	Unsure how work in staff where there is a culture of dislike of being observed.

3B	Leah	30-39	5-10	Class teacher	Enjoys, interested in and confident to teaching maths. Mostly not difficult, except some concepts.	Unsure	Overall positive. It challenged me to approach my teaching in a broad way. I became more of a facilitator of the children's learning. They navigated their own learning. I was anxious to teach in front of colleagues.	I don't think it's a one-size fits all situation. We all learn differently. I would prefer a more informal approach e.g. teaching to a small class group. Gaining ideas and insights into how my colleagues approach teaching.	Being in the spotlight (observations). The mix of personalities in the team. We all processed differently, and it can be a challenge to take all views on board.
3C	Lorraine	40-49	25-30	Class teacher	Enjoys, interested in and confident to teaching maths. Not difficult.	Yes	Positive experience. More open now to collaborative methods of teaching. More open-minded. More open to observing and being observed.	Very hands-on and practical. Less about writing notes (plans). Coming together of supportive colleagues. Teaching from where children are. Teachable moments. Letting children work it out for themselves.	Takes a huge amount of time. Invested a lot of time into one aspect. Teachers already time poor.